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UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary
GEOLOGICAL SURVEY
W. C. Mendenhall, Director

SUGGESTIONS TO AUTHORS

OF

PAPERS SUBMITTED FOR PUBLICATION BY THE UNITED STATES GEOLOGICAL SURVEY

WITH

DIRECTIONS TO TYPISTS

By GEORGE McLANE WOOD
EDITOR, 1908–1925

✦

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(REVISED AND ENLARGED)

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Note to fourth edition

The third edition of Mr. Wood's "Suggestions to authors" was published in 1916 and has been reprinted seven times in response to continued and widespread demand, which has included requests from many foreign countries. Although the pamphlet has thus obviously proved useful, experience in using it has shown that expansion to set forth still more clearly the reasons for the suggestions would be desirable. Mr. Wood fully realized this need and had hoped to find time, after his retirement from the Geological Survey, to prepare a manual of somewhat wider scope for outside publication. He had accumulated some material for this purpose, but the requests for his help on technical manuscripts left him so little time of his own that death found his hope unfulfilled.

As Mr. Wood's associate for the last 20 years of his Government service and his successor in office, I have ventured to attempt a revision and expansion of the "Suggestions." The present edition, like the others, is intended primarily for Geological Survey authors or prospective authors: it is not the manual of wider scope that Mr. Wood had planned, and it contains none of his new material. If authors outside the Survey shall continue to find the suggestions useful, that will be a byproduct that testifies to the quality of the Survey's standards, which were established early in its history.

Some sections have been entirely rewritten, much new matter has been included, and an effort has been made to clarify and expand suggestions that have proved to be so brief as not to be readily understood by some authors and to add suggestions beaten out on the anvil of daily work in editing Survey manuscripts. If some of the explanations seem almost rudimentary and therefore unnecessary for scientific writers, the answer must be that experience has proved that they are not unnecessary—that some writers need just such explanations to enable them to recognize the faults in their writing and understand how to correct them.

The examples of faulty expression given in this book are all genuine, and all but a very few have been taken from manuscripts submitted by Survey authors. Some of them have been shortened by omitting words not essential in illustrating the point to be made, but none have been "manufactured" for the purpose.

The suggestions relating to reports on mining districts have been rewritten by G. F. Loughlin, chief of the section of metalliferous deposits, and a new section on ground-water papers has been contributed by O. E. Meinzer, chief of the division of ground water. The suggestions relating

to paleontologic papers have been revised by J. B. Reeside, Jr., chief of the section of paleontology and stratigraphy; the section on geologic names has been checked by H. D. Miser, chairman of the committee on geologic names; and the section on chemical terms and symbols has been checked by R. C. Wells, chief of the section of chemistry and physics. Valuable help has been given by my assistants on the editorial staff, Arthur W. Harkness, Mary F. Bugbee, and Anna Jespersen.

The section on typographic style has been changed to bring it into accord with the recently revised Style Manual of the Government Printing Office, and some additions have been made to the directions to the Survey typists, whose cooperation is so great a help in lessening the mechanical work of the editorial staff.

B. H. L.

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SUGGESTIONS TO AUTHORS

By George McLane Wood

Fourth edition, revised and enlarged by Bernard H. Lane

General requirements

Although the geologist may with advantage include in his field notes [1] carefully written descriptions that can be transcribed literally into the manuscript of his report, he should generally not attempt to dictate offhand from his notebook with the intention of rearranging and polishing the typewritten matter thus obtained to form a final report but should study and classify his notes and material before he begins to write. He should also remember that the facts he desires to express may be presented to the reader not only by the text but by geologic sections, tables, diagrams, maps, or half-tone plates produced from photographs. Moreover, an illustration may show clearly what it would be practically impossible to set forth in the text.

The author's preliminary study of material should include the examination of specimens and samples collected in the field and the preparation of maps, sketches, and photographs for illustrations, and it may involve the reexamination of earlier reports, which should have been freely consulted before the field work was begun. He should at the outset carefully consider the general arrangement of the matter of his paper. The notes, memoranda, and extracts made in his preliminary study should be sorted and classified under the subject heads adopted, which should be set down in proper order in a provisional table of contents.

Before preparing a paper for publication an author should examine the Survey's recent printed reports on like subjects or areas and familiarize himself with the details of their form, many of which are set forth in this pamphlet. Special suggestions relating to reports on mining districts, paleontologic papers, and papers on ground water are given on pages 31–43 and will be serviceable in indicating the proper treatment in many papers of other kinds. They are, of course, only supplemental to the suggestions given on other pages, which apply to all Survey publications.

[1] Hayes, C. W., Handbook for field geologists in the United States Geological Survey, pp. 45-60, 1908.

The title of a paper should be as brief as it can be made and, with the name of the author, should appear not only on the title page but at the top of the first page of text—that is, the first page of the abstract (see pp. 43–45), not the first page after the abstract.

If the report has been prepared in cooperation with a State or other organization the cooperation should be acknowledged on the cover and title page, in the form "Prepared in cooperation with * * *", and stated fully in the text.

Survey reports are not generally divided into "chapters", and headings are not numbered.

The use of numerous cross references, especially references to "another part of this paper" or "a subsequent connection", is not desirable. It may be necessary to repeat, in another connection, a statement that is made elsewhere in the report, but such a repetition should not be preceded by "As already stated" or a similar phrase—in fact, reference to the original statement is unnecessary unless it contains details to which the reader's attention should be again called but which would occupy too much space if repeated. (See also p. 91.) Such terms as "earlier" and "later", implying time, should not be used in cross references; it is better to cite the page numbers, but as page numbers cannot be supplied until the paper has reached the stage of page proof, such references should be kept at a minimum.

The material in a Survey report should rarely need apology or explanation. It must be generally recognized that no author is writing a monograph on every topic which he mentions and, on the other hand, that if he discusses some subject he believes it of sufficient importance to justify the space taken. The reader may be assumed to be more interested in the subject matter than in the author's mental processes.

Every paper should include an abstract setting forth its principal results or conclusions. Suggestions to authors of abstracts, revised from a circular prepared by a committee of the geologic branch, are given on pages 43–45.

In many papers it may be desirable to include a bibliography of the subject or area discussed. An annotated bibliography, in which the title of each book or paper listed is followed by a brief summary of its contents, may be preferable to a mere list of titles, but the annotations should be skillfully prepared and should emphasize the parts of the works listed that are especially pertinent to the subject or area. Entries in a bibliography should be written in the style prescribed for footnotes on pages 16–30.

The author should read carefully the final draft of his report—the completed manuscript—before he submits it to the chief of his section or division.

Every paper should be transmitted to the Director by the chief of the branch in which it originated, whose recommendation for its publication

will be regarded as an approval of its scientific or technical features. If a paper originating in one branch contains matter pertaining to the work of another, the chief under whom the paper originated should, before transmitting it to the Director for publication, refer it to the chief of the other branch for revision (if necessary) and approval of that part of it which pertains to the work of his branch. If the paper contains geologic names both text and illustrations should be referred to the chief geologist for checking by the committee on geologic names, before it is transmitted to the Director.

All Survey manuscripts are prepared for the printers by the editorial staff in the section of texts. The editorial work includes the examination of the character and gradation of headings, the form of footnotes, the use of geographic and geologic names, the form of tables and sections, and the various features of typographic style—such as sizes and styles of type, capitalization, punctuation, and spelling—as well as many other details. (See pp. 103–111.) Much of this work is done according to prescribed rules, such as those of the Style Manual of the Government Printing Office, or mandatory decisions, such as those of the United States Geographic Board, the Division of Geographic Names, or the Survey's committee on geologic names.

The editorial work includes also suggestions to the author concerning the arrangement of matter, paragraphing, the correction of faults or errors in grammar or rhetoric, the clarification of obscure passages, the elimination of repetitious or irrelevant matter, and many other features, such as are discussed under the general heading "Suggestions as to expression" on pages 49–102 of this pamphlet.

After editorial revision the manuscript will be returned to the author in order that he many examine the suggestions or corrections made. If any of the editorial changes seem to him to be undesirable he should confer or correspond with the editor and endeavor to reach an agreement without delay. If the edited manuscript is acceptable to the author he need only write "O. K.", his initials, and the date on the back of the title page.

Form and features of manuscript

The best printer's copy

The best copy for the printer is typewritten on letter paper of ordinary thickness and uniform size. Government letter paper is 8 by 10½ inches; the size commonly used outside the Government is 8½ by 11 inches. A mixture of these two sizes is awkward to handle and should be avoided. Thin manifold paper should not be used. A carbon copy of the manuscript should be made and retained by the author, and the original (not the carbon) should be transmitted for publication. The typewriting should be on only one side of the paper, double- or triple-spaced. Nothing should be written single-spaced except literal quotations, and care

should be taken to see that they are really literal, as single-spaced writing does not leave room for corrections. Ample margins should be left—an inch at the top and left and at least half an inch at the right and bottom.

Because the copy is distributed to the typesetting-machine operators in lots of a few pages each, no paragraph should be broken at the bottom of a page. To remedy breaks in paragraphs it is necessary to cut and paste the manuscript—a task that consumes time, adds to the expense of printing, and produces sheets of different sizes, which are inconvenient to handle. For these reasons manuscripts intended for publication should, as far as possible, be so written that each paragraph is complete on the page where it begins. It is not necessary to fill every sheet completely with writing. Short pages are better than broken paragraphs. It may happen that a single paragraph cannot be kept within one page, but such long paragraphs should be avoided if possible. If new matter for which there is not room on the page already written is inserted, it should be written on a separate sheet, and the sheet in which it is to be inserted should be cut apart at the proper place and each part pasted on a blank sheet of regular size. It may be necessary to write the copy for wide tables on large sheets, which should preferably be either twice or four times the size of the regular sheets. Copy for tables should not be crowded, and the whole of a table need not appear on one sheet. Matter for long bibliographies or other similar works may be written on cards.

Temporary numbers may be placed at the bottoms of the pages, but before the manuscript is transmitted, after all inserts and additions have been made, the pages should be numbered consecutively, beginning with the cover or title page, not with the first page of the text.

Manuscript should not be folded or rolled but should be kept flat and transmitted in a secure envelop or cover. Drawings or photographs that are intended for use as illustrations should be kept separate from the manuscript, not inserted in it, but should be transmitted at the same time.

Table of contents and list of illustrations

The manuscript should include a table of contents (headed "Contents") and a list of illustrations (headed "Illustrations"). Only words that should be capitalized in the text should be capitalized in these lists.

The table of contents should be a transcript of the headings appearing in the manuscript, so written as to indicate by indention their relative rank—their coordination and subordination. The manuscript page numbers given should be those that have been finally assigned, after the manuscript is complete. A specimen table of contents is given on page 5.

CONTENTS

	Manuscript page
Abstract	1
Introduction	1
Location and area of the region	1
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Relief	5
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Water resources	40
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The list of illustrations should contain only brief titles, but these should correspond, as far as they go, with the full titles that are to be printed with the illustrations. The manuscript page numbers given in the list should be those of the pages containing the principal references to the respective illustrations. It is especially necessary to give these page numbers, so that they may serve as a guide to the final numbering of the illustrations if any of the author's figures are made plates, or vice versa. A specimen list of illustrations is given below. The words "Plate" and "Figure" are each written only once, and the numbers are alined as shown. Two copies of the list should be furnished—the original and a carbon. (See also pp. 46, 47.)

ILLUSTRATIONS

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Plate 1. Topographic reconnaissance map of the Broad Pass region, Alaska	6
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Headings

A proper scheme of headings is essentially a rational classification of the material embodied in the paper, as may be seen by reference to the specimen table of contents given on page 5. All coordinate or similar groups of matter should be provided with headings of similar rank.

It is undesirable and generally unnecessary to provide headings of more than four or five grades. Excessive refinement in subdividing the text of a paper is confusing rather than enlightening to the reader. The headings of the lowest grade may be italic side headings; the others are center headings. The rank of the center headings will be shown by printing them in distinctive faces of type, properly graded as to size. The word or words that immediately follow a side heading should preferably not consist of a mere repetition of the heading, but as the text should be complete in itself, independent of the headings, so that it will be perfectly intelligible even if read without them, some repetition may be unavoidable.

Headings should preferably indicate the thing or things described or discussed in the text, not the text itself; the italicized words in the following quoted headings are therefore superfluous: "*Description of the* Cretaceous rocks", "*Discussion of* ore deposits", "*Statement of theories of* origin of the ore", "*Description of* the mines", "*Table showing* lead produced in 1915." The heading "General features", if it is applicable, should be used rather than "General statement", but it is not necessary to insert a perfunctory heading over a brief general statement that precedes detailed descriptions for which appropriate headings can be provided. Headings like "Introduction" and "Summary" are exceptions to the rule stated above, but some manuscript reports contain too many headings of this kind, especially "Introduction", which is used in numerous places where it should be omitted or replaced by a heading denoting specifically the features considered in the text beneath it. One "Introduction" and one "Summary" are enough for a single report. If a summary of one of the subdivisions seems desirable the heading should be so worded as to indicate the subject discussed—for example, "Summary of conditions affecting ore deposition."

Geologic names

All geologic names are considered by the Survey's committee on geologic names before they are printed in a publication of the Survey. As it is necessary to obtain that committee's approval of the particular use in any paper of names of members, formations, groups, series, systems, epochs, and periods, even if only casual references are made to them, the committee examines the manuscript and also such illustrations as bear geologic names. This examination should be made before the paper is transmitted to the Director for publication. A few of the general decisions of the committee and some other pertinent matter are given below.

The following is a table of accepted names for eras, periods or systems, and epochs or series:

Geologic eras, periods, systems, epochs, and series

Era	Period or system	Epoch or series
Cenozoic	Quaternary	Recent. Pleistocene (replaces "Glacial").
	Tertiary	Pliocene. Miocene. Oligocene. Eocene.
Mesozoic	Cretaceous	Upper (Gulf may be used provincially). Lower (Comanche and Shasta may be used provincially).
	Jurassic	Upper. Middle. Lower.
	Triassic	Upper. Middle. Lower.
Paleozoic	Carboniferous	Permian. Pennsylvanian (replaces "Upper Carboniferous"). Mississippian (replaces "Lower Carboniferous").
	Devonian	Upper. Middle. Lower.
	Silurian.	
	Ordovician	Upper (Cincinnatian may be used provincially). Middle (Mohawkian may be used provincially). Lower.
	Cambrian	Saratogan (or Upper Cambrian). Acadian (or Middle Cambrian). Waucoban (or Lower Cambrian).
Proterozoic	Pre-Cambrian.	

The symbols used on maps to indicate the periods or systems are given below.

Q Quaternary	Ŧ Triassic	O Ordovician
T Tertiary	C Carboniferous	Ꞓ Cambrian
K Cretaceous	D Devonian	pꞒ pre-Cambrian
J Jurassic	S Silurian	

The following names, if used in a titular sense, are permissible only when put in quotation marks:

"Coal Measures" (subdivision of the Carboniferous).
"Calciferous" (subdivision of the Ordovician).
"Corniferous."
"Juratrias."
"Lignitic."
"Magnesian" (subdivision of the Ordovician).
"Permo-Carboniferous."
"Red Beds" (Permian and Triassic rocks of the West).

The foregoing decisions are not intended to preclude the use of "coal measures", "calciferous", "lignitic", "magnesian", and "red beds" as common nouns or adjectives. Use the forms "glacial", "preglacial", "postglacial."

The adjectives "upper", "middle", and "lower", when used with "Carboniferous", "Tertiary", or "Quaternary", should not be capitalized unless the term is quoted. When used with the names of other systems they may be capitalized if the term is used in a definite sense. When

applied to subdivisions of series or to indefinite or local subdivisions of stratigraphic units they should not be capitalized. Examples: Upper Cambrian; Upper Cretaceous; Lower Devonian; Mississippian ("Lower Carboniferous"); middle Miocene; lower Colorado.

A dagger (†) preceding a geologic name indicates that the name has been abandoned or rejected for use in classification in publications of the United States Geological Survey. Quotation marks, formerly used to indicate abandoned or rejected names, are now used only in the ordinary sense.

Geographic names

In the spelling of geographic names preference will be given to (1) decisions of the Division of Geographic Names (or its predecessor, the United States Geographic Board), (2) quadrangle maps published by the United States Geological Survey (latest editions), (3) reports of the Census of the United States, (4) United States Postal Guide, (5) United States Land Office maps, (6) Century Atlas of the World and Century Dictionary of Names.

Names whose form is doubtful and proposed new names should be submitted to the Division of Geographic Names for determination. As that division must consider evidence in passing on new names, time must be allowed for its action; the names should be submitted as long as possible before the report is to be transmitted for publication.

"The" should be used with names of rivers and in general with group names in the plural (or equivalents of such names) but not with names of creeks, runs, arroyos, washes, etc., nor with names of single mountains or peaks: The Colorado River, the Potomac and Susquehanna Rivers, the Middle Fork of the Piedra River, the Great Smoky Mountains, the Spanish Peaks, the Cascade Range; Rock Creek, Difficult Run, Salt Wash, Mount Mitchell, Pikes Peak.

In a few geographic names "The" (capitalized) is an essential part of the name: The Needle, The Dalles, The Weirs.

Care should be taken to avoid repetition in such names as Sierra Nevada (not Sierra Nevada Mountains), Blue Ridge (not Blue Ridge Mountains), Rio Grande (not Rio Grande River).

Hyphens in petrographic terms

The Survey has adopted a uniform scheme for the use of hyphens in petrographic terms, based on the single principle that like names are connected by a hyphen and unlike names are not. The names used in such terms are of four classes—(*a*) rock names, (*b*) mineral names, (*c*) textural names, and (*d*) names expressing the kind of clastic aggregation. Any two or more names of the same class are connected by a hyphen; others are not. For example, in "hornblende-quartz andesite" the two mineral names are connected by a hyphen; in "quartz monzonite

porphyry", consisting of a mineral name, a rock name, and a textural name, no hyphens are used. The principal names of classes *c* and *d* are as follows: (*c*) Felsophyre, gneiss, porphyry, schist, vitrophyre; (*d*) agglomerate, breccia, conglomerate, sand, tuff. If a name is used only as an adjective, as in "potash feldspar" or "gold quartz veins", it is not followed by a hyphen.

The subjoined list is not complete but will serve to illustrate the principle. To avoid confusion, a term that, according to this principle, is not hyphenated should remain without the hyphen when it becomes a unit modifier preceding some other word—for example, bostonite porphyry, bostonite porphyry dike.

Expressions like "granite-syenite contact" should be avoided, as the hyphen seems to indicate a single rock. Say "granite and syenite contact" or, preferably, "contact of the granite and syenite."

acmite trachyte
actinolite-magnetite schist
adamellite gneiss
aegirite-augite
aegirite granite
aegirite granite porphyry
albite diorite
albite-oligoclase
albite schist
alkali syenite porphyry
amphibole-biotite granite
amphibole granite
amphibole picrite
analcite basalt
andalusite hornfels
andalusite schist
andesine-labradorite
andesite-basalt
andesite breccia
andesite vitrophyre
anorthite andesite
apatite syenite
augite-biotite andesite
augite-bronzite andesite
augite diorite
augite-hornblende gabbro
augite latite
augite-mica syenite
augite-microcline granite
augite monzonite
augite peridotite
barium feldspar
basalt tuff
biotite-augite latite
biotite diorite
biotite gneiss
biotite-hornblende-quartz latite
biotite-pyroxene andesite
biotite-quartz monzonite
biotite rhyolite
biotite schist
biotite tinguaite
bostonite porphyry
breccia-agglomerate
breccia-conglomerate
bronzite norite
bronzite-olivine aleutite
cancrinite syenite
chiastolite schist
clay shale
clay slate
cordierite andesite
cordierite hornfels
cordierite norite
corundum anorthosite
corundum pegmatite
dacite tuff
diopside hornstone
diorite porphyry
diorite schist
enstatite diabase porphyry
epidote-chlorite schist
essexite porphyry
felsite tuff
gabbro-diabase
gabbro-diorite
gabbro porphyry
gabbro-pyroxenite
gabbro-syenite
garnet norite
glaucophane schist
granite gneiss

granite-monzonite
granite-syenite porphyry
greenstone conglomerate
greenstone schist
grünerite-magnetite schist
haüynite phonolite
hornblende andesite
hornblende andesite agglomerate
hornblende andesite porphyry
hornblende-augite andesite
hornblende-biotite-quartz latite
hornblende gneiss
hornblende granite
hornblende-mica andesite
hornblende-mica diorite
hornblende-mica granite
hornblende peridotite
hornblende-quartz andesite
hypersthene-augite andesite
hypersthene gabbro
ilmenite norite
keratophyre tuff
labradorite-bytownite
latite-andesite
latite-phonolite
leucite absarokite
leucite basalt
leucite basanite
leucite granite porphyry
leucite tephrite
leucite tuff
lime feldspar
lime-soda feldspar
lithia mica
magnesia mica
magnetite gabbro
melaphyre tuff
melilite basalt
melilite monchiquite
melilite-nephelite basalt
mica dacite
mica diorite
mica diorite porphyry
mica gabbro porphyry
mica gneiss
mica-hornblende norite
mica hornblendite
mica peridotite
mica schist
monzonite porphyry
natrolite phonolite
nepheline basalt
nepheline-melilite basalt
nephelite basalt
nephelite basanite
nephelite felsite
nephelite syenite porphyry
noselite-leucite tephrite
noselite sanidinite
olivine andesite
olivine-augite andesite
olivine diabase
olivine melaphyre
orthoclase gabbro
orthoclase gabbro-diorite
picrite porphyry
plagioclase basalt
plagioclase gneiss
potash feldspar
pseudoleucite syenite
pyroxene andesite breccia
pyroxene-biotite andesite
pyroxene-mica andesite
quartz-augite diorite
quartz-augite syenite
quartz-biotite-garnet gneiss
quartz diorite gneiss
quartz diorite porphyry
quartz gneiss
quartz-hornblende-mica monzonite
quartz keratophyre
quartz-mica-hornblende diorite
quartz-mica latite
quartz monzonite
quartz monzonite gneiss
quartz monzonite porphyry
quartz norite
quartz norite gneiss
quartz-pyroxene diorite
quartz schist
quartz syenite porphyry
quartz-tourmaline porphyry
quartz trachyte
rhyolite-dacite
rhyolite-latite
rhyolite porphyry
saussurite gabbro
sericite schist
soda feldspar
soda granite
soda-lime feldspar
soda microcline
soda minette
soda orthoclase
sodalite syenite
sodalite tephrite

syenite-diorite porphyry
syenite felsophyre
syenite-monzonite
syenite porphyry
talc schist
tephrite tuff
theralite porphyry
tourmaline-biotite schist
tourmaline granite
trachyte-andesite
trachyte tuff
tridymite trachyte
tuff-agglomerate
tuff-breccia
uralite diorite
zoisite-hornblende diorite

Tables and leader work

The purpose of a table is to present in a concise and orderly manner information that could not be presented so clearly in any other way. Leader work is a simple form of tabulation, usually only two columns, printed without vertical or horizontal rules.

A table should preferably be introduced by some statement in the text, but such a statement should not be a duplicate of the matter in the table heading, and if no other pertinent introductory matter can be provided the table should be inserted without an introduction.

As a rule each table or leader-work statement should be provided with a concise, clear heading that indicates the principal items of information included. It is undesirable to number tables unless the numbers are needed for convenience of reference in other parts of the text. If they are numbered, arabic numerals should be used (table 1; not table I, nor table no. 1). The words "Table showing" should not be used in the heading, nor is it necessary to include in the heading minor items that are incidental to the main features. Headings for statistical tables should generally begin with a concrete rather than an abstract term—for example, "Gold produced in the Willow Creek district in 1933" is better than "Production of gold * * *."

The proper arrangement of a table may be difficult. Few general rules can be given, and if a table is complicated the author should consult the editor to ascertain its proper form. This instruction applies to all tables except those that can be patterned after printed tables in recent Survey publications. The time necessary for this consultation will be far less than that required to correct a table that is improperly prepared.

The author should remember that tables are to be set in type by men who are not geologists or engineers and that the prime requisite of a manuscript table is legibility. The printers should not be compelled to guess at the matter in the table or at the way in which it should be arranged. The writing should not be crowded. Paper is cheaper than the time of anyone who has to handle the table after it is written.

Geologic sections should be "right side up" (or top side up)—that is, the printed items representing the beds are arranged in the order in which the beds would be shown in a graphic section or drawing, the

youngest at the top, the oldest at the bottom. The beds in a section should not be numbered unless the numbers are needed for convenience of reference in other parts of the text. If the beds must be numbered it is permissible to begin numbering either from the top or from the bottom, according to the purpose of the section.

A typical geologic section is given below.

Generalized section of formations in Ouachita Mountains, Ark.

	Feet
Carboniferous: Stanley shale	6,000
Unconformity.	
Age unknown:	
Fork Mountain slate	100
Arkansas novaculite	800
Missouri Mountain slate	300
Probable unconformity.	
Ordovician:	
Blaylock sandstone	1,500
Polk Creek shale	100
Bigfork chert	700
Stringtown shale	100
Unconformity.	
Ouachita shale	900
Crystal Mountain sandstone	700
Probable unconformity.	
Age unknown: Collier shale (observed thickness)	200
	11,400

The form given below indicates the style preferred by some authors. The rock term is given first and is followed by the descriptive adjectives. If this form is used, it should be followed consistently throughout a report. Its purpose is to give emphasis to the material in each bed rather than to its particular color, texture, or other features, but the device is effective only where the term to be emphasized comes first in the line, and hence it is unnecessary to invert the second term in a unit that includes material of two kinds: "Shale, sandy, and fine-grained sandstone" (not "and sandstone, fine-grained"). This form also shows the style to be used if both feet and inches are given.

Section of rocks underlying the Dakota sandstone in sec. 9, T. 21 S., R. 8 E.

	Ft.	in.
Shale, bluish gray	1	3
Sandstone, brownish gray, cross-bedded, somewhat carbonaceous	2	
Clay shale, bluish gray; contains leaves of several species (unidentified)		8
Shale, sandy, coarse-grained, conglomeratic	1	10
Shale, drab		3
Clay, white, calcareous, lenticular		2
Shale, drab, with yellow iron concretions	1	
Shale, sandy, bluish		3
Shale, sandy, drab, yellow, and gray	1	6
	8	11

More elaborate geologic sections are usually given in the following form. (The table is not complete but is adequate to show the general style.) The manner of centering, the alinement, and the position of "Unconformity" should be especially noted.

Summary of exposed rock formations in the Book Cliffs region, Colorado

Age	Group, formation, and member	Character	Thickness (feet)	Economic value
Quaternary		Alluvial material covering terrace remnants in front of cliffs; sandstone, sand, and algal limestone; locally stream gravel containing pebbles of igneous and metamorphic rocks.	0–30	None.
	—Unconformity—			
Tertiary (Eocene).	Green River formation (basal part). Douglas Creek member.	An aggregation of gray-green shale, papery gray shales, algal and ostracode limestone, and buff calcareous sandstone; few very thin layers of oil shale. The predominant color is gray.	600–1,000	No recognized mineral value. Water from this horizon sweeter than from beds below.
	Wasatch formation.	Variegated clay shale, some sandy, containing a few beds of massive sandstone and numerous thin sandy lenses; some fresh-water limestone; locally conglomeratic at base.	280–790	No recognized mineral value.
	—Unconformity—			
Tertiary(?) (Eocene ?).		Mainly gray-white sandstone intercalated with clay shales, some of which are variegated. Major erosional unconformity at base, marked by conglomeratic sandstone 10 to 40 feet thick.	155–370	No recognized mineral value.
	—Unconformity—			
Upper Cretaceous.	Mesaverde group. Hunter Canyon formation.	Assemblage of massive brown, buff, and gray cliff-making fluviatile sandstone and gray clay shale. About 60 percent sandstone and 40 percent shale.	375–1,400	Thin seams of coal in carbonaceous shale near top. No economic value. Sandstone too soft for building stone.
	Mesaverde group. Mount Garfield formation.	An assemblage in which sandstone averages about 33 percent, shale 51 percent, shaly sandstone 10 percent, carbonaceous shale 6 percent. The sandstones are much like those above but not so thick or coarse.	405–665	A few thin beds of coal are present, none of minable thickness. There are considerable beds of carbonaceous shale.

In connection with analyses the name of the analyst (with initials) should be given, in the form "[W. F. Hillebrand, analyst]", immediately below the heading. If the samples are numbered use arabic (1, 2, 3, etc.), not roman (I, II, III). The term "percent" is not necessary above the figure column if the total approximates 100.

Simple well or drill-hole records should preferably appear in the following form:

Record of Winters well, Southwest City, Mo.

	Thickness (feet)	Depth (feet)
Surface and coarse rock	48	48
Blue flint	30	78
Light-gray rock	20	98
Dark-brown flint	12	110

Records for a large area containing many wells may include a variety of data. For such complex tables it is especially desirable to consult the editor as to the general form and details of statement before writing the table. The items to be included may vary according to local conditions, but some good examples of general form are afforded by the well tables in Water-Supply Papers 639, 640, and 656.

Chemical terms and symbols

The preferred forms of certain chemical terms are shown in the first column below. The forms in the second column should not be used.

Univalent	Monovalent
Bivalent	Divalent
Trivalent	Tervalent
Quadrivalent	Tetravalent
Quinquivalent	Pentavalent
Aluminum	Aluminium
Beryllium	Glucinum
Beryllia	Glucina
Columbium	Niobium
Columbic	Niobic
Columbate	Niobate

The following list of chemical elements and symbols is based on the latest available information (1935):

Chemical elements and symbols

Element	Symbol	Element	Symbol	Element	Symbol
Actinium	Ac	Helium	He	Radon	Rn
Alabamine	Ab	Holmium	Ho	Rhenium	Re
Aluminum	Al	Hydrogen	H	Rhodium	Rh
Antimony	Sb	Indium	In	Rubidium	Rb
Argon	A	Illinium	Il	Ruthenium	Ru
Arsenic	As	Iodine	I	Samarium	Sa
Barium	Ba	Iridium	Ir	Scandium	Sc
Beryllium	Be	Iron	Fe	Selenium	Se
Bismuth	Bi	Krypton	Kr	Silicon	Si
Boron	B	Lanthanum	La	Silver	Ag
Bromine	Br	Lead	Pb	Sodium	Na
Cadmium	Cd	Lithium	Li	Strontium	Sr
Calcium	Ca	Lutecium	Lu	Sulphur	S
Carbon	C	Magnesium	Mg	Tantalum	Ta
Cerium	Ce	Manganese	Mn	Tellurium	Te
Cesium	Cs	Mercury	Hg	Terbium	Tb
Chlorine	Cl	Molybdenum	Mo	Thallium	Tl
Chromium	Cr	Neodymium	Nd	Thorium	Th
Cobalt	Co	Neon	Ne	Thulium	Tm
Columbium	Cb	Nickel	Ni	Tin	Sn
Copper	Cu	Nitrogen	N	Titanium	Ti
Dysprosium	Dy	Osmium	Os	Tungsten	W
Erbium	Er	Oxygen	O	Uranium	U
Europium	Eu	Palladium	Pd	Vanadium	V
Fluorine	F	Phosphorus	P	Virginium	Vi
Gadolinium	Gd	Platinum	Pt	Xenon	Xe
Gallium	Ga	Potassium	K	Ytterbium	Yb
Germanium	Ge	Praseodymium	Pr	Yttrium	Y
Gold	Au	Protactinium	Pa	Zinc	Zn
Hafnium	Hf	Radium	Ra	Zirconium	Zr

In the text of chemical or geochemical papers either chemical symbols (as "H_2S") or terms (as "hydrogen sulphide") should be used; terms and symbols should not be mixed indiscriminately. For some chemical com-

binations, however, no terms are available. In tables of analyses symbols alone or in less technical papers both terms and symbols may be used, the term first, followed by the symbol in parentheses, as "silica (SiO_2)."

Personal acknowledgments

Assistance rendered by persons not connected with the Survey should be acknowledged, but a statement of the nature of the assistance is ordinarily sufficient: the author's gratitude may be taken for granted. As a rule it is unnecessary to mention general assistance rendered by other members of the Geological Survey: nearly every Survey report by the time it reaches the printer has had the benefit of suggestions by many of the author's colleagues as a part of their routine work, so that the report is a product of the organization, and such contributions need not be recounted. Specific pieces of work, however, such as analyses, identifications of minerals or fossils, or computations, should be credited to the persons who made them. Such credit is polite; it is honest; and it fixes the responsibility. Usually it is also desirable to mention the section or division chief under whose supervision the work was done, as next to the author he is primarily responsible for the report.

Titles of honor, office, distinction, or address (such as Dr., Prof., Mr.) should be used only where the mention is personal, as in acknowledgment of courtesies or services. Such titles should be omitted from the names of authors cited and, if first name or initials are given, from names of coauthors or scientific collaborators. In personal mention of a member of the Survey use "Mr."

Mr. G. W. Jefferson guided the writer to the place.

Van Hise says * * *

George Otis Smith's work on * * *

The economic geology is discussed by Mr. Loughlin in part 2.

Analyst, W. F. Hillebrand. This rock was analyzed by Dr. Hillebrand.

The invertebrate fossils were identified by Mr. Reeside and the fossil plants by Mr Brown.

Quotations

Responsibility for the accuracy of references and quotations must rest with the author: they will not usually be verified in the editorial revision. In reprinted matter the exact words of the original should be preserved, but it is not necessary to reproduce typographic errors or details of printer's style, such as spelling, capitalization, and punctuation, except in quotations in which, for obvious reasons, quaintness or exactness of form should be preserved. Omissions in quoted matter should be indicated by three stars, but it is not necessary to use stars at the beginning or end of a quotation.

Examination of the original sources of many unintelligible quotations has shown that errors are sometimes made in copying printed matter. The typewritten copy of every quotation should be carefully compared with the original.

Footnote and other citations

Footnotes to text

Before making a footnote an author should carefully consider whether the matter does not belong in the text. Proper footnotes consist chiefly of references to the literature of the subject discussed. However, a note that has a collateral bearing on the subject matter of the text and is of sufficient pertinence to be included but would be too much of an interruption if inserted in the text may be made a footnote. Some authors have the habit of putting into a footnote any matter that came to mind after the sentence or paragraph in which it properly belongs was first written, as shown in the subjoined extracts from manuscripts presented for publication:

These were analyzed [1] and the original supposition was confirmed.

[1] By Mr. Wheeler.

I have already described the fauna of the [Mutt] limestone as it occurs at [Jeffersonville]. The present paper describes a fauna which was found at the same locality [1] in the overlying bed.

[1] Railroad cut 1½ miles west of the depot.

As the footnotes are numbered consecutively in the printed report, the numbering should be deferred until all additions or eliminations have been made and the manuscript is ready to send to the printer. This final numbering will be done in the editor's office, and the references should therefore be left without numbers in the manuscript. Each footnote, however, should be written immediately below the line in which the reference mark is to appear and should be separated from the text above and below by lines. Superior figures ($^{1, 2, 3}$) are used for reference marks in text, and the places for them should be indicated by a "shelf" (_/) at each reference. The "shelf" should preferably be written immediately after the name of the author cited, but not if the name is in the possessive form ("Gilbert's theory _/") or if the matter is complicated by containing references to two or more papers by the author cited or to different parts or statements in a single paper. Personal names should include initials, to make identification certain, especially for indexing. The initials should ordinarily not be given in the text; they should be included in the footnotes.

The items of a footnote should be written in the order prescribed below:

1. Name of author cited (surname first, initials or given name next), followed by a comma. If there is only one given name, write it in full, as Lindgren, Waldemar; if more than one, write only initials, as Brooks, A. H.

2. Title of work or paper cited, which should be given exactly and as a rule in full. Begin first word of title with capital letter; begin all other

words except proper nouns or adjectives with small letters. If the paper or report cited appears in a periodical or serial publication, put colon after title; if it is an independent work, put comma after title.

3. Name of periodical or of series of publications in which paper cited appears, with volume or number (in arabic numerals), page (roman or arabic, as in work cited), plate or figure (arabic), and, finally, date of publication. If place of publication and publisher's name seem necessary for identification, put them just before the date.

Page references should be specific—to the page or pages on which the particular matter cited appears, not simply the first page of the work cited nor the first and last pages unless the reference is a general one to the whole work. It is unfair to the reader who may wish to look up a reference to compel him to hunt for the appropriate place in the work cited, and the author should note the particular pages at the time he selects the reference, so that he may include them in his citation. Citations to papers published in serials should include both the title of the paper and the title of the serial. The decision of the reader whether to look up the citation may be governed by the nature of the paper as indicated by its title, and the title of the serial alone gives him only an inadequate clue.

The following typical footnotes should be examined in detail, as to punctuation, capitalization, order of items, and abbreviations: [2]

Gilbert, G. K., Recent earth movement in the Great Lakes region: U. S. Geol. Survey 18th Ann. Rept., pt. 2, pp. 637–639, 1898.

Van Hise, C. R., A treatise on metamorphism: U. S. Geol. Survey Mon. 47, pp. 691–697, 1904.

Lindgren, Waldemar, The Tertiary gravels of the Sierra Nevada of California: U. S. Geol. Survey Prof. Paper 73, p. 44, 1911.

Shaler, N. S., The geology of Nantucket: U. S. Geol. Survey Bull. 53, pp. 42–47, 1889.

Leighton, M. O., and Tavernier, René, The public utility of water powers and their governmental regulation: U. S. Geol. Survey Water-Supply Paper 238, p. 75, 1910.

Hayes, C. W., U. S. Geol. Survey Geol. Atlas, Pikeville folio (no. 21), p. 3, 1895.

Smith, G. O., The economic limits to domestic independence in minerals: Mineral Resources U. S., 1917, pt. 1, pp. 1a–6a, 1921.

Clark, M. B., and Shuey, E. T., Summary of mineral production [1932–33]: Minerals Yearbook, 1932–33, Statistical appendix, pp. A1–A40, 1934.

McGee, W J, Soil erosion: U. S. Dept. Agr., Bur. Soils, Bull. 71, 1911.

Chamberlin, T. C., The diversity of the glacial period: Am. Jour. Sci., 3d ser., vol. 45, pp. 171–200, 1893.

Williams, E. H., Jr., The heating in the Culebra Cut: Science, new ser., vol. 35, pp. 892–893, 1912.

Becker, G. F., Schistosity and slaty cleavage: Jour. Geology, vol. 4, p. 445, 1896.

Brooks, A. H., Applied geology: Washington Acad. Sci. Jour., vol. 2, pp. 43–44, 1912.

Branner, J. C, The phosphate deposits of Arkansas: Am. Inst. Min. Eng. Trans., vol. 26, p. 584, 1896.

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[2] For a description of Survey practice see Lane, B. H., A uniform scheme for citations: Science, new ser., vol. 73, pp. 390–392, Apr. 10, 1931; More about citations: Idem, vol. 74, pp. 338–339, Oct. 2, 1931.

Powers, Sidney, Occurrence of petroleum in North America: Am. Inst. Min. Met. Eng. Tech. Pub. 377, 46 pp., 1931.

Willis, Bailey, Oil of the northern Rocky Mountains: Eng. and Min. Jour., vol. 72, pp. 782–784, 1901.

Clarke, J. M., The origin of the Gulf of St. Lawrence: New York State Mus. Bull. 164, pp. 132–137, 1913.

Tarr, R. S., and Von Engeln, O. D., A laboratory manual of physical geography, pp. 309–312, 1910.

Wright, W. B., The Quaternary ice age, p. 374, London, Macmillan Co., 1914.

Dana, J. D., Manual of geology, 4th ed., pp. 207–226, 1895.

In English titles of books or articles only the first word, proper nouns, and proper adjectives are capitalized; in English titles of serials (abbreviated as indicated on pp. 22–29) principal words are capitalized; in foreign citations the particular national practice is followed throughout except that the first word of a society's name or a series of publications (or the abbreviation for it) is capitalized.

In citing papers included in the Survey's series of "Contributions" to general and economic geology and hydrology or other similar collections of separate papers, give the author and title of the particular paper cited, not the title of the series.

The matter after the colon in a footnote citing a Survey publication should begin "U. S. Geol. Survey", and the matter after the colon in a footnote citing a serial published by a society or other organization should begin with the name of the organization, written in the style indicated by examples given on pages 22–29. The name of a State organization should begin with the name of the State, written in full.

To recapitulate, the prescribed order of the items in a footnote citing a paper from a serial publication is as follows: Name of author; title of paper (followed by a colon); name of journal; volume; part or number (if necessary); pages; plates and figures (if necessary); place of publication (if necessary); publisher (if necessary); date of publication.

If, however, the serial has no other distinctive numeral designation of volume than the year of publication, the designation of the year should be written in the place of the number of the volume and not repeated at the end of the citation. For example, the Neues Jahrbuch takes for a distinctive number the year of publication and was formerly issued as Band 1 and Band 2 for each year. In citing this publication the date should be inserted in the place of the volume number ("Neues Jahrb., 1914, Band 1") and not repeated at the end. Recent issues of this publication should be cited as "Neues Jahrb., 1930, Referate, I" (or II or III). The Beilage-Band of the Neues Jahrbuch, however, carries a distinctive number and should be cited in the ordinary way, with the date at the end ("Neues Jahrb., Beilage-Band 15, p. 150, 1902"). Beginning with volume 52 the Beilage-Band has been issued in two parts each year, and in citations "Abt. A" or "Abt. B" should be inserted after the volume number.

Some annual reports have no distinctive number and are designated by the year covered in the report but may not be published in that year. In citing such a report both dates should be given—for example: "U. S. Geol. and Geog. Survey Terr. Ann. Rept. for 1874, pp. 271–365, 1876."

If the date of publication differs from the date given in the imprint, it may be desirable, especially if questions of priority are involved, to give both dates:

Lee, W. T., and Knowlton, F. H., Geology and paleontology of the Raton Mesa and other regions in Colorado and New Mexico: U. S. Geol. Survey Prof. Paper 101, p. 346, 1917 [1918].

The order of items in a footnote citing an independent work (a book that is not one of a series, though it may be in several volumes or parts) is the same as that indicated above so far as the items given are applicable—that is, name of author; title of work (followed by a comma); volume or part (if necessary); pages; plates and figures (if necessary); place of publication (if necessary); publisher (if necessary); date of publication.

The prescribed abbreviations for names of States (see list on p. 105) should be used after names of counties, cities, towns, reservations, or national forests and after names of rivers, lakes, or other natural features, but no other abbreviations should be used in the quoted title of a paper or book except such as are given in the original title itself. In the name of a periodical or of a series of publications in which a paper cited appears the abbreviations indicated below should be used.

Use "U. S." in "U. S. Geol. Survey" or in names of other Government bureaus, offices, or departments, but spell in full all names of countries, States, and cities in such citations as "Illinois Geol. Survey," "New York Acad. Sci.", "Cincinnati Soc. Nat. History", "Geol. Soc. America", "Royal Soc. Canada."

Use "1st", "2d", "3d", etc., for serial numbers of reports so designated, as "U. S. Geol. Survey 21st Ann. Rept.", "Vermont State Geologist 8th Rept.", also "U. S. Geol. Expl. 40th Par.", "2d ed." (not "2nd ed."), "3d ser." (not "3rd ser.").

In foreign citations such terms as the German "Band", "Heft", "Abt." (Abteilung), and "Lief." (Lieferung) or the French "tome" and "livr." (livraison) should be followed, not translated into "vol.", "pt.", etc. It is not necessary, however, to use the German "S." (Seite) for "p." or "pp."

The abbreviations used in Geological Survey citations are based on the plan of giving enough to indicate the words with reasonable clearness. Below is a list of unit forms that are frequently used. The words in parentheses explain the abbreviations and are not to be used in citations. This list is not a guide to capitalization, as the capitalization of many of these words depends on their position in the citation. (See list on pp. 22–29.)

Abh. (Abhandlung)
Abt. (Abteilung)
Acad. (academy, académie, academía)
Accad. (accademia)
Acta
Actes
Agr. (agriculture, agricultural)
Akad. (Akademie)
Allg. (allgemeine)
Am. (American)
America
Anal. (analytical, etc.)
Angew. (angewandte)
Ann. (annual)
Annaes, Annalen, Annales, Annals
année
año
Anorg. (anorganisch)
Anz. (Anzeiger)
Arb. (Arbeiten)
Årb. (Årbok)
Archiv, Archives, Archivio, Arkiv
Assoc. (association)
Atti
Av. (avancement)
Band
Beitr. (Beitrag, Beiträge)
Ber. (Bericht)
Bienn. (biennial)
Bind
Biol. (biologic, etc.)
Bol. (boletim, boletín)
Boll. (bollettino)
Bot. (botanic, etc.)
Botany
Bull. (bulletin)
Bur. (bureau)
Centralbl. (Centralblatt)
Chem. (chemical, etc.)
Chemie
Chemistry
Chim. (chimique)
Chimie
Cien. (ciencia, ciencias)
Cient. (científica)
Circ. (circular)
Cl. (Classe)
Coll. (college, collections)
Com. (comisión, comité)
Comm. (commission, committee, communications)
Compte rendu
Comptes rendus
Cong. (congress)
Cons. (conservation)
Contr. (contributions)
Deel
Denkschr. (Denkschrift)
Dept. (department)
Devel. (development)
Div. (division)
Econ. (economic)
Eng. (engineers, engineering)
Erläut. (Erläuterungen)
Exper. (experiment)
Expl. (exploration)
Fac. (faculty, etc.)
fig., figs. (figure, figures)
Foram. (foraminiferal)
Fören. (Förening)
Förh. (Förhandlingar)
Fortschr. (Fortschritte)
Franç. (français)
Gazette
Gazz. (gazzetta)
Gen. (general)
Gén. (générale)
Geog. (geographic, etc.)
Géog. (géographique)
Geographie, géographie
Geography
Geol. (geologic, etc.)
Géol. (géologique)
Geologie, géologie
Geologist
Geology
Gesell. (Gesellschaft)
Gior. (giornale)
Govt. (Government)
Grossh. (grossherzoglich)
Hälfte
Handl. (Handlingar)
Heft, Hefte
Hist. (historical, etc.)
History
Hüttenm. (hüttenmännisch)
Imp. (imperial, etc.)
Ind. (industrial, etc.)
Industry
Inf. (information)
Ing. (ingenieurs, ingenieros, etc.)
Inst. (institute, institution)
Internat. (international)
Inv. (investigation)
Irr. (irrigation)
Ist. (istituto)
Izv. (izvestiya)
Jaarb. (jaarboek)
Jahrb. (Jahrbuch)
Jahresber. (Jahresbericht)
Jahresh. (Jahresheft)
Jahrg. (Jahrgang)

Jour. (journal)
K. (kaiserlich, königlich)
Kl. (Klasse)
Lab. (laboratory)
Lief. (Lieferung)
Lit. (literary)
Livr. (livraison)
Mag. (magazine)
Math. (mathematical, etc.)
Mem. (memoir, memoria, memorandum)
Mém. (mémoire)
Met. (metallurgical, etc.)
Metallurgy, metalurgía
Micr. (microscopic)
Min. (mineral, mineraria, minières, mining)
Minas, Mines
Minera
Mineralog. (mineralogic, etc.)
Mineralogía, minéralogie
Mineralogy
Minería
Minero
Misc. (miscellaneous)
Mitt. (Mitteilungen)
Mon. (monograph)
Monatsber. (Monatsbericht)
Monatsh. (Monatsheft)
Monatsschr. (Monatsschrift)
Montan. (montanistich)
Monthly
Mtn. (mountain)
Mus. (museo, museum, etc.)
Nac. (nacional)
Nachr. (Nachrichten)
Nat. (national, natural)
Naturalist
Nature
Naturf. (Naturforscher, naturforschende)
Naturh. (naturhistorisch)
Naturwiss. (naturwissenschaftlich)
neue Folge
new ser.
no., nos. (number, numbers)
Nr. (Nummer)
Occ. (occasional)
p., pp. (page, pages)
Palaeontologie
Palaeont. (palaeontologisch)
Paleont. (paleontologic, etc.)
Paleontology
Pamph. (pamphlet)
Paper, Papers
Philos. (philosophical)
Physical
Physics
Physikal. (physikalisch)
pl., pls. (plate, plates)
Polytech. (polytechnic, etc.)
Prakt. (praktisch)
Proc. (proceedings)
Prof. (professional)
Prosp. (prospecting)
pt., pts. (part, parts)
Pub. (publication)
Quart. (quarterly)
R. (reale)
Rec. (record, records, recueil)
Rend. (rendiconti)
Rept. (report)
Rev. (review, revue, revista)
Riv. (rivista)
Royal, royale
R. R. (railroad)
Ry. (railway)
Schr. (Schrift)
Sci. (science, sciences, scientific, etc.)
Science (the journal so named)
Seismol. (seismologic, etc.)
Seismology
Seismotech. (seismotechnical, etc.)
Selsk. (Selskab)
ser. (series)
Service
Sitzungsber. (Sitzungsbericht)
Skr. (Skrift)
Soc. (society, société, etc.)
Sta. (station)
Summary
Survey
Tech. (technical, etc.)
Technology
Teil
Tidskr. (tidskrift)
Tidsskr. (Tidsskrift)
Tijdschr. (tijdschrift)
Tijdskr. (tijdskrift)
Trans. (transactions)
Travaux
Univ. (university, etc.)
U. S. (United States)
Vaterl. (vaterländisch)
Ver. (Verein)
Verh. (Verhandlung, etc.)
Vetensk. (vetenskaps)
Vidensk. (videnskabernes, videnskaps)
vol., vols. (volume, volumes)
Wetensch. (Wetenschappen)
Wiss. (Wissenschaft)
Wochenschr. (Wochenschrift)
Zeitschr. (Zeitschrift)
Zeitung
Zool. (zoological, etc.)
Zoology

The following list of forms for citing serial publications, which is manifestly incomplete, will serve as a general guide for citations not included in the list. Many of the organizations here named issue more than one series of publications, and the series designation given in this list (Proc., Trans., Bull., Ber., etc.) should, of course, be changed to correspond with the particular publication being cited. The original publication should be followed in the use or nonuse of the designation "vol."—for example, "Geol. Soc. America Bull., vol. 34", "Canadian Min. and Met. Bull. 239." The "no." is omitted in such designations as "Bull. no. 239", "Mem. no. 65", "Pub. no. 875." Such titles as "Académie des sciences, belles-lettres et arts" are shortened to "Acad. sci." Geographic names and other proper nouns are written in full.

Aargau. naturf. Gesell. Mitt.
Abh. geol. Specialkarte Preussen
Acad. nat. cien. Córdoba Actas
Acad. nat. sci. Bordeaux Actes
Acad. Nat. Sci. Philadelphia Proc.
Acad. polonaise sci. Bull. internat.
Acad. roumaine, Sec. sci., Bull.
Acad. royale Belgique Mém. cour. et sav. étrang.
Acad. royale sci. Belgique Mém.
Acad. royale sci. Denmark Mém.
Acad. sci. Lyon Mém.
Acad. sci. Paris Comptes rendus
Acad. sci. Paris Mém. sav. étrang.
Acad. Sci. St. Louis Trans.
Acad. sci. Toulouse Mém.
Acad. sci. U. R. S. S. Bull.
Acad. tchèque sci. Bull. internat.
Accad. gioenia sci. nat. Atti
Accad. sci. Acireale Rend. e mem.
Accad. sci. Ist. Bologna Mem.
Accad. sci. Torino Mem.
Accad. sci. veneto-trentino-istriana Atti
Acta chem., min. et phys.
Acta geog.
Agence gén. colonies Bull.
Akad. Nauk Izv.
Akad. Wiss. Wien, Math.-naturwiss. Kl., Denkschr.
Alabama Geol. Survey Rept. Progress
Albany Inst. Proc.
Alberta Sci. Ind. Research Council Repts.
Allg. Jour. Chemie
Am. Acad. Arts Sci. Proc.
Am. Assoc. Petroleum Geologists Bull.
Am. Ceramic Soc. Jour.
Am. Geophys. Union Trans.
Am. Inst. Min. Met. Eng. Trans.[3]
Am. Jour. Botany
Am. Jour. Sci., 5th ser.[4]
Am. Micr. Soc. Trans.
Am. Midland Naturalist
Am. Mineralogist
Am. Mus. Nat. History Bull.
Am. Mus. Novitates
Am. Naturalist
Am. Petroleum Inst. Production Bull.
Am. Water Works Assoc. Jour.
Am. Year Book
Annaes sci. nat.
Annalen der Chemie (Liebig)
Annalen der Physik (Poggendorff)
Annales de géographie
Annales de paléontologie
Annales des mines
Annals and Mag. Nat. History
Annals of Botany
Appalachia
Archaeol. Inst. America Bull.
Archiv Hydrobiologie
Archiv prakt. Geologie
Archives sci. phys. nat.
Arctic Inst. Trans.
Arizona Bur. Mines Bull.
Arkansas Geol. Survey Inf. Circ.
Arkiv für Botanik
Assoc. Am. Geographers Annals
Assoc. Am. State Geologists Jour.
Assoc. Eng. Soc. Jour.
Assoc. franç. av. sci. Bull.
Assoc. ing. école Liége Bull.
Assoc. min. siciliana Boll.
Astrophys. Jour.
Ateneo sci. Bergamo Atti
Auckland Inst. and Mus. Rec.
Augustana Library Pubs.

[3] Omit the "Met." before vol. 68.

[4] Do not omit the series number.

Auk
Australasian Inst. Min. Metallurgy Proc.
Australian and New Zealand Assoc. Adv. Sci. Rept.
Australian Mus. Rec.
Australian Sci. Abstracts
B. P. Bishop Mus. Bull.
Badische geol. Abh.
Barbados Mus. Hist. Soc. Jour.
Bayer. Akad. Wiss., Math.-naturwiss. Abt., Abh.
Beitr. angew. Geophysik
Beitr. geol. Karte Schweiz
Beitr. Geologie Thüringen
Beitr. Geophysik
Beitr. Paläontologie Oesterr.-Ungarns u. des Orients
Berg- u. hüttenm. Jahrb. Leoben
Bergens Mus. Årbok
Berliner geog. Arbeiten
Biochem. Zeitschr.
Biol. Abstracts
Biol. Rev.
Biologia generalis
Birmingham Nat. History and Philos. Soc. Proc.
Black Hills Engineer
Bol. minas y petróleo
Bol. minero
Bol. oficial minas
Bol. petróleo
Boston Jour. Nat. History
Boston Soc. Nat. History Proc.
Bot. Archiv
Bot. Gazette
Bot. Jahrb.
Bot. Közlemények
Bot. Mag.
Braunkohle
Brennstoff-Chemie
British Columbia Bur. Mines Ann. Rept.
Buffalo Soc. Nat. Sci. Bull.
Bulgarian Geol. Soc. Rev.
Bull. Am. Paleontology
Bull. volcanologique
Calcutta Univ. Dept. Sci. Jour.
California Dept. Public Works, Water Resources Div., Bull.
California Div. Mines Rept.
California Jour. Mines and Geology
California Min. Bur. Bull.
California Oil Fields
California Univ., Dept. Geol. Sci., Bull.
Cambridge Philos. Soc. Proc.
Canada Geol. Survey Summary Rept.
Canada Nat. Mus. Bull.
Canadian Field Naturalist
Canadian Geog. Jour.
Canadian Inst. Min. Metallurgy Trans.
Canadian Jour. Research
Canadian Min. Jour.
Canadian Min. Met. Bull.
Canadian Min. Rev.
Canadian Naturalist
Canterbury Mus. Rec.
Cardiff Naturalists Soc. Trans.
Carnegie Inst. Washington Pub.
Centralbl. Mineralogie,[5] Abt. A [or B]
Ceramic Soc. Trans.
Chem. Eng. and Min. Rev.
Chem. Met. Eng.
Chem., Met. Min. Soc. South Africa Jour.
Chem. News
Chem. Rev.
Chem. Soc. London Jour.
Chem.-Zeitung
Chem. Zentralbl.
Chemie der Erde
Chicago Acad. Sci. Bull.
Chimie et industrie
China Geol. Survey Geol. Bull.
Chosen Geol. Survey Bull.
Chronique mines coloniales
Cincinnati Quart. Jour. Sci.
Cincinnati Soc. Nat. History Jour.
Colliery Engineer
Colorado Geol. Survey Bull.
Colorado Mus. Nat. History Proc.
Colorado School of Mines Quart.
Colorado Sci. Soc. Proc.
Colorado Univ. Studies
Colorado-Wyoming Acad. Sci. Jour.
Com. geol. ital. Boll.
Com. mapa geol. España Bol.
Com. spécial Katanga Annales
Comm. geog. e geol. Minas Geraes Bol.
Comm. géol. Finlande Bull.
Condor
Connecticut Acad. Arts and Sci. Trans.
Connecticut Geol. and Nat. History Survey Bull.
Contr. U. S. Nat. Herbarium
Cushman Lab. Foram. Research Contr.
Copenhague Univ., Mus. minéralogie et géologie, Comm. paléont.
Danmarks geol. Undersøgelse

[5] Insert the date here, as this publication has no volume number.

Dansk. geol. Fören. Medd.
Davenport Acad. Sci. Proc.
Denison Univ., Sci. Lab., Bull.
Deutsche bot. Gesell. Ber.
Deutsche geol. Gesell. Zeitschr.
Die Eiszeit
Die Naturwissenschaften
Dingler's polytech. Jour.
12e Cong. géol. internat. Compte rendu
Durham Univ., Philos. Soc., Proc.
Earthquake Notes
Eclogae geol. Helvetiae
Ecology
Econ. Geology
Edinburgh Geol. Soc. Trans.
Eiszeit u. Urgeschichte
Elisha Mitchell Sci. Soc. Jour.
Eng. and Min. Jour.[6]
Eng. Mag.
Eng. News-Record
Eng. Soc. Western Pennsylvania Proc.
Entomol. Soc. America Annals
Essex Inst. Ann. Rept.
Faculté sci. Marseille Annales
Fennia 54 [not "vol. 54"]
Field Mus. Nat. History Pub., Geol. ser.
Finska vetensk.-soc. Acta
Florida Geol. Survey Bull.
Földtani Közlöny
Forestry-Geol. Rev.
Fortschr. Geologie u. Palaeontologie
Fortschr. Mineralogie
Franklin Inst. Jour.
Freiberger geol. Gesell. Ber.
Gazz. chim. italiana
Génie civil
Geog. Annaler
Geog. geol. Mededeel.
Geog. Gesell. Hannover Jahresber.
Geog. Gesell. Wien Mitt.
Geog. Jahresber. Oesterreich
Geog. Jour.
Geog. Rev.
Geog. Soc. Philadelphia Bull.
Geog. Vestnik
Geog. Wochenschr.
Geog. Zeitschr.
Geol. Bundesanstalt Jahrb.
Geol. fören. Stockholm Förh.
Geol. Gesell. Wien Mitt.
Geol. Landesanstalt, Geol. Spezialkarte Baden, Erläut.
Geol. Landesunters. bayer. Oberbergamt Abh.
Geol. Mag.[7]
Geol.-mijnb. genootsch. Nederland en Kolonien Verh., Geol. ser.
Geol., Min. Met. Soc. India Quart. Jour.
Geol. Reichs-Mus. Leiden Samml.
Geol. Rundschau
Geol. Soc. America Bull.
Geol. Soc. London Quart. Jour.
Geol. Soc. South Africa Trans.
Geol. Soc. Tokyo Jour.
Geol. Soc. Washington Proc.
Geol. u. palaeont. Abh.
Geol. Zentralbl.
Geologists' Assoc. London Proc.
Georgia Div. Geology Inf. Circ.
Georgia Geol. Survey Bull.
Gerlands Beitr. Geophysik
Gesell. Beförd. gesamt. Naturwiss. Marburg Sitzungsber.
Gesell. Erdkunde Berlin Zeitschr.
Gesell. naturf. Freunde Berlin Sitzungsber.
Gesell. Wiss. Gottingen, Math.-phys. Kl., Abh.
Gesundheits-Ing.
Gior. sci. nat. econ.
Glückauf
Great Britain Geol. Survey Summary of Progress
Greifswald Univ., Geol.-palaeont. Inst., Abh.
Grenoble Univ., Lab. géologie, Travaux
Grossh.-bad. geol. Landesanstalt Mitt.
Grossh.-hess. geol. Anstalt Abh.
Hamburg min.-geol. Staatsinst. Mitt.
Haidinger's Naturwiss. Abh.
Hamilton Assoc. Sci. Jour.
Harvard Coll. Mus. Comp. Zoology Bull.
Harvard Univ. Bot. Mus. Leaflets
Hobbies
Home Geog. Monthly
Hopkins Seaside Lab. Contr. Biology
Idaho Bur. Mines and Geology Pamph.
Illinois Acad. Sci. Trans.
Illinois Geol. Survey Bull.
Imp. Acad. Japan Proc.
Imp. Earthquake Inv. Comm. Pub.

[6] Eng. and Min. Jour.-Press from vol. 113, p. 513, to end of vol. 121.

[7] Issued by "decades" prior to 1920. For early citations give the decade number (dec. 4, etc.).

Ind. and Eng. Chemistry
India Geol. Survey Mem.
Indiana Acad. Sci. Proc.
Indiana Dept. Cons. Pub.
Indiana Div. Geology Pub.
Indochine Service géol. Bull.
Inst. Égypte Mém.
Inst. fiz.-khim. anal. Izv.
Inst. geol. México Parergones
Inst. geol. min. España Mem.
Inst. ing. Chile Anales
Inst. Min. Eng. Trans.
Inst. Min. Metallurgy Trans.
Inst. Petroleum Technologists Bull.
Inst. royal colonial belge Bull.
Iowa Acad. Sci. Proc.
Iowa Geol. Survey
Iowa Univ. Studies in Nat. History
Jaarb. mijnwezen Ned.-Indië
Jahrb. Chemie
Japanese Jour. Geology and Geography
Johns Hopkins Univ. Studies in Geology
Jour. Agr. Research
Jour. Botany
Jour. conchyliologie
Jour. Geography
Jour. Geology
Jour. Paleontology
Jour. pétrole
Jour. physique
Jour. prakt. Chemie
Jour. Rheology
Jour. Sedimentary Petrology
K. Akad. Wetensch. Amsterdam Verh.
K. bayer. Akad. Wiss., Math.-naturh. Kl., Sitzungsber.
K. böhm. Gesell. Wiss. Jahresber.
K. danske vidensk. Selsk. Mat.-fys. Meddel.
K.-geod. Inst. Jahresber.
K. norske vidensk. selsk. Forh.
K. preuss. Akad. Wiss., Phys.-math. Kl., Sitzungsber.
K. sächs. Akad. Wiss., Math.-phys. Kl., Abh.
K. svenska vetensk. akad. Handl.
K. vetensk.-soc. Upsala Nova acta.
Kali, Erz u. Kohle
Kansas Acad. Sci. Trans.
Kansas Geol. Survey Bull.
Kansas Univ. Geol. Survey
Kansas Univ. Sci. Bull.
Kentucky Dept. Geology and Forestry, ser. 5
Kentucky Geol. Survey, ser. 6
Kosmos
Kyoto Imp. Univ., Coll. Sci., Mem.
La Géographie
Lake Superior Min. Inst. Proc.
La Terre et la vie
Le Globe
Leeds Philos. Lit. Soc. Proc.
Linnean Soc. London Jour., Botany
Linnean Soc. New South Wales Proc.
Los Angeles Junior Coll. Pub.
Los Angeles Mus. Pub.
Lotos
Louisiana Dept. Cons. Geol. Bull.
Louisiana Geol. Survey Special Rept.
Louvain Univ., Inst. géol., Mém.
Lyceum Nat. History New York Annals
Lyon Univ., Lab. géologie, Travaux
Magyar tudom. akad. Math. termész ért.
Maine State Geologist 2d Ann. Rept.
Manchester Lit. Philos. Soc. Mem. and Proc.
Marseille Mus. histoire nat. Annales
Maryland Geol. Survey
Massachusetts Inst. Technology, Dept. Mining, Contr.
Meddelelser om Grönland
Metall u. Erz
Michigan Acad. Sci. Papers
Michigan Geol. and Biol. Survey Pub.
Michigan Univ., Mus. Paleontology, Contr.
Michigan Univ. Papers in Geography
Micropaleontology Bull.
Mid-Pacific Mag.
Military Engineer
Milwaukee Pub. Mus. Bull.
Min. and Eng. World
Min. and Ind. Rec.
Min. Cong. Jour.
Min. Inst. Scotland Trans.
Min. Jour.
Min. Met. Soc. America Bull.
Min. pet. Mitt.
Mineral Industry
Mineral Resources of Oregon
Mineral Resources U. S.
Mineralog. Mag.
Mineralog. Soc. Southern California Bull.
Minerals Yearbook
Mines Mag.
Mining and Metallurgy
Mining Mag.
Minnesota Geol. and Nat. History Survey Ann. Rept.
Minnesota Geol. Survey Bull.

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Mississippi Geol. Survey Bull.
Missouri Bur. Geology and Mines Bienn. Rept.
Missouri Univ. Studies
Mon. Geologie u. Palaeontologie
Monatsh. Chemie
Montan. Rundschau
Montana Bur. Mines and Metallurgy Mem.
Monthly Weather Rev.
Moscow Geol. Prosp. Service Bull.
Mus. civico storia nat. Genoa Annali
Mus. histoire nat. Marseille Annales
Mus. nac. Rio de Janeiro Archivos
Mus. nat. histoire nat. Bull.
Mus. Northern Arizona Mus. Notes
Mus. royale histoire nat. Belgique Mém.
Nat. Acad. Sci. Proc.
Nat. Bur. Standards Research Paper
Nat. Gas
Nat. Geog. Mag.
Nat. History
Nat. History Soc. Glasgow Trans.
Nat. Research Council Bull.
Nat. Research Inst. Geology Contr.
Natur u. Museum
Natur u. Volk
Nature
Naturf. Gesell. Basel Verh.
Naturf. Gesell. Halle Abh.
Naturf. Ver. Brünn Verh.
Naturh.-med. Ver. Heidelberg Verh.
Naturh. Mus. Wien Annalen
Naturh. Staatsmus. Annalen
Naturh. Ver. preuss. Rheinlande u. Westfalens Sitzungsber.
Naturwiss. Gesell. Isis Dresden Sitzungsber.
Naturwiss. Monatsschr.
Naturwiss. Rundschau
Naturwiss. Ver. Bremen Abh.
Naturwiss. Ver. Schleswig-Holstein Schr.
Naturwiss. Wochenschr.
Natuurk. tijdschr. Ned.-Indië
Nautilus
Nebraska Geol. Survey Bull.
Nebraska State Mus. Bull.
Nederlandsch Aardrijksk. Genootschap Amsterdam Tijdschr.
Neues Jahrb.[8]
Neues Jahrb., Beilage-Band [8]
Neues Jahrb., Referate [8]
Neues Jour. Physik
Nevada Bur. Mines Bull.
Nevada State Mineralogist Rept.
Nevada Univ. Bull.
New Hampshire State Geologist 1st Rept.
New Jersey Geol. Survey Ann. Rept.
New Mexico Bur. Mines Bull.
New Mexico School of Mines Bull.
New Phytologist
New South Wales Dept. Mines Ann. Rept.
New York Acad. Sci. Annals
New York Bot. Garden Bull.
New York Mineralog. Club Bull.
New York State Mus. Bull.
New Zealand Jour. Sci. Technology
Norges geol. undersökelse
Norsk geol. tidsskr.
Norske vidensk.-akad. Oslo Årbok
North Carolina Dept. Cons. and Devel. Bull.
North Carolina Geol. and Econ. Survey Bull.
North Dakota Geol. Survey Bienn. Rept.
North Dakota Univ. Quart. Jour.
Northwest Sci.
Nova Acta Leopoldina
Nova Scotian Inst. Sci. Proc. and Trans.
Nyt mag. naturvidensk.
Oberrhein. geol. Ver. Jahresber.
Oesterr. Zeitschr. Berg- u. Hüttenwesen
Office nat. combust. liquides Annales
Ohio Geol. Survey, 4th ser., Bull.
Ohio Jour. Sci.
Oil and Gas Jour.
Oil Weekly
Oildom
Oklahoma Acad. Sci. Proc.
Oklahoma Geol. Survey Bull.
Ontario Dept. Mines Rept.
Oregon Mineralogist
Pacific Mineralogist
Palaeont. Soc. Pub.
Palaeont. Zeitschr.
Palaeontographica
Palaeontologia Indica
Palaeontologia Sinica
Pan-Am. Geologist
Pan-Pacific Mag.
Peabody Mus. Nat. History Mem.
Pennsylvania Geol. Survey, 4th ser., Bull.
Pennsylvania 2d Geol. Survey Rept. T[3]
Pennsylvania Topog. and Geol. Survey Bull.
Petermanns Mitt.
Petroleum
Petroleum Times

[8] For method of citing the Neues Jahrbuch see p. 18.

Philippine Jour. Sci.
Phys.-ökon. Gesell. Königsberg Schr.
Phys. Rev.
Plant World
Polytech. Centralbl.
Pont. accad. sci. Nuovi Lincei Mem.
Portland Soc. Nat. History Proc.
Preuss. geol. Landesanstalt Abh.
Priroda [Leningrad]
Psyche
Puerto Rico Univ. Mon.
Quart. Jour. Micr. Sci.
Quebec Bur. Mines Ann. Rept.
Queensland Govt. Min. Jour.
Queensland Geol. Survey Pub.
Quekett Micr. Club Jour.
R. accad. d'Italia Annuario.
R. accad. d'Italia, Cl. sci. fis., mat. e nat., Mem.
R. accad. Lincei, Cl. sci. fis., mat. e nat., Mem.
R. accad. sci. Zelanti Atti
R. com. geol. Italia Mem.
R. ist. veneto sci. Atti
R. soc. geog. italiana Boll.
R. soc. sci. upsaliensis Nova acta
R. ufficio geol. Boll.
Rassegna min. met. italiana
Rassegna sci. geol. Italia
Rec. travaux chim.
Rep. Argentina, Dir. minas y geología, Bol.
Rev. gén. botanique
Rev. gén. sci. pures et appl.
Rev. geog. americana
Rev. géographie phys. et géologie dynamique
Rev. industrial
Rev. industrie minérale
Rev. minera
Rev. obras públicas de Puerto Rico
Rev. questions scientifiques
Rev. scientifique
Rev. univ. mines
Rhode Island Nat. Resources Survey Bull.
Riv. geog. italiana
Riv. italiana paleontologia
Riv. servizio min.
Rochester Acad. Sci. Proc.
Rocks and Minerals
Royal Canadian Inst. Trans.
Royal Dublin Soc. Sci. Proc.
Royal Geol. Soc. Cornwall Proc.
Royal Irish Acad. Proc.
Royal Micr. Soc. Jour.
Royal Soc. Canada Proc. and Trans., 3d ser.
Royal Soc. London Philos. Trans.
Royal Soc. New South Wales Jour. and Proc.
Russ. K. min. Gesell. Verh.
Sächs. Akad. Wiss., Math.-phys. Kl., Abh.
San Diego Soc. Nat. History Trans.
Santa Barbara Mus. Nat. History Occ. Papers
Schweizer. bot. Gesell. Ber.
Schweizer. min. pet. Mitt.
Schweizer. naturf. Gesell. Verh.
Schweizer. palaeont. Gesell. Abh.
Sci. Am.; Sci. Am. Suppl.
Sci. Jour.
Sci. Monthly
Sci. Progress
Sci. Soc. China Trans.
Science [9]
Scotland Geol. Survey Mem.
Scottish Geog. Mag.
Scripps Inst. Oceanography Bull.
Sec. fomento Rep. mexicana Anales
Seismol. Soc. America Bull.
Senckenberg. naturf. Gesell. Abh.
Service géol. Pologne Bull.
Services carte géol. France Bull.
Siebenburg. Ver. Naturwiss. Verh. u. Mitt.
Sierra Club Bull.
16th Internat. Geol. Cong. Guidebook
Smithsonian Inst. Ann. Rept.
Smithsonian Misc. Coll.
Soc. belge géologie Bull.
Soc. agr., sci. et ind. Lyon Annales
Soc. bot. France Bull.
Soc. Chem. Industry Jour.
Soc. chim. France Bull.
Soc. cient. Antonio Alzate Mem.
Soc. cient. argentina Anales
Soc. cubana hist. nat. Mem.
Soc. cubana ing. Rev.
Soc. española historia nat. Bol.
Soc. études sci. Angers Bull.
Soc. franç. minéralogie Bull.
Soc. geog. Lima Bol.
Soc. geog. nac. Madrid Bol.

[9] Published in three series, though the first and second series were not so designated. Should be cited as "Science [1st ser.]" (vols. 1, 2, 1880–81), "Science [2d ser.]" (vols. 1–23, 1883–94), "Science, new ser." (vols. 1– , 1895–).

Soc. geog. Rio de Janeiro Rev.
Soc. géographie Lille Bull.
Soc. géol. Belgique Annales, Pub. rel. Congo belge
Soc. géol. France Compte rendu
Soc. geol. italiana Boll.
Soc. geol. mexicana Bol.
Soc. géol. Nord Annales
Soc. helvétique sci. nat. Actes
Soc. ind. min. Bull.
Soc. ing. civils France Mém.
Soc. italiana sci. nat. Atti
Soc. linnéenne nord France Bull.
Soc. nac. minería (Chile) Bol. minero
Soc. naturalistes Moscou Bull.
Soc. naturalisti Napoli Boll.
Soc. neuchâteloise sci. nat. Bull.
Soc. océanographie France Bull.
Soc. phys. et histoire nat. Genève Compte rendu
Soc. royale belge géographie Bull.
Soc. royale sci. Bohème, Cl. sci., Mém.
Soc. russe géog. Izv.
Soc. russe minéralogie Mém.
Soc. sci. Bruxelles Annales
Soc. sci. Chili Actes
Soc. sci. Fennicae Acta
Soc. toscana sci. nat. Atti
Soc. vaudoise sci. nat. Mém.
South African Jour. Sci.
South African Mus. Annals
South Carolina Geol. Survey Bull.
South Dakota Geol. and Nat. History Survey Bull.
South Dakota Geol. Survey Rept. Inv.
South Wales Inst. Eng. Proc.
Southern California Acad. Sci. Bull.
Southport Soc. Nat. Sci. 1st Rept.
Spelaeol. Soc. Proc.
Stanford Univ., Dept. Geology, Contr.
Staten Island Inst. Arts and Sci. Proc.
Svensk bot. tidskr.
Sveriges geol. undersökning
Tanganyika Geol. Survey Ann. Rept.
Technology Quart.
Teknisk tidsskr.
Tennessee Acad. Sci. Jour.
Tennessee Div. Geology Bull.
Terra
Texas Geol. Survey Ann. Rept.
Texas Univ. Bull.
Tohoku Imp. Univ. Sci. Repts., 2d ser.
Tokyo Imp. Univ., Fac. Sci., Jour., sec. 2
Tonindustrie-Zeitung
Toronto Univ. Studies, Geol. ser.
Torrey Bot. Club Bull.
Torreya
Tulsa Geol. Soc. Digest
U. S. Bur. Mines Econ. Paper
U. S. Bur. Mines Inf. Circ.
U. S. Bur. Mines Rept. Inv.
U. S. Dept. Agr. Tech. Bull.
U. S. Dept. Interior Press Mem. 72602 [10]
U. S. Geog. and Geol. Survey Rocky Mtn. Region Rept.
U. S. Geog. Surveys W. 100th Mer. Rept. ("and Geol." should be added after "Geog." for vol. 3 and some other reports; see Bulletin 222)
U. S. Geol. and Geog. Survey Terr. 9th Ann. Rept. ("and Geog." should be omitted for some of the earlier reports; see Bulletin 222)
U. S. Geol. Expl. 40th Par. Rept.
U. S. Geol. Survey Prof. Paper (for other series see sample footnotes on p. 17)
U. S. Nat. Mus. Proc.
U. S. Pacific R. R. Expl.
Ungar. Akad. Wiss. Math. naturwiss. Anz.
Union géod. géophys. internat., Sec. seismologie, Mon.
United Geol. Prosp. Service U. S. S. R. Trans.
Univ. Bruxelles, Inst. zool. Torley-Rousseau, Rec.
Univ. Jassy Annales sci.
Univ. Masaryk, Fac. sci., Pub.
Upsala Univ., Geol. Inst., Bull.
Utah Acad. Sci. Proc.
Ver. Erdkunde Dresden Mitt.
Ver. Freunde naturh. Mus. Veröffentl.
Ver. Naturkunde Kassel Abh.
Ver. vaterl. Naturkunde Württemberg Jahresh.
Ver. Verbreitung naturwiss. Kenntnisse Wien Schr.
Vermont State Geologist 17th Rept.
Victoria Inst. Jour.
Vidensk selsk. Oslo Forh.
Virginia Acad. Sci. Proc.
Virginia Geol. Survey Bull.
Virginia Univ., Philos. Soc., Bull., Sci. ser.
Wagner Free Inst. Sci. Bull.
Washington Acad. Sci. Jour.

[10] The number should be given; it usually appears at the bottom of the last page, preceded by "P. N."

Washington Div. Geology Bull.
Washington Geol. Survey Ann. Rept.
Washington Univ. [Seattle] Pub. in Geology
Washington Univ. [St. Louis] Studies, new ser.
Water Works Eng.
West Virginia Acad. Sci. Proc.
West Virginia Geol. Survey County Repts.
West Virginia Univ. Bull.
Western Soc. Eng. Jour.
Wisconsin Acad. Sci. Trans.
Wisconsin Geol. and Nat. History Survey, Sci. ser., Bull.
World Petroleum
Wyoming Geol. Survey Bull.
Zeitschr. allg. Erdkunde
Zeitschr. anal. Chemie
Zeitschr. angew. Chemie
Zeitschr. Berg-, Hütten- u. Salinenwesen preuss. Staate
Zeitschr. Geomorphologie
Zeitschr. Geophysik
Zeitschr. Gletscherkunde
Zeitschr. Kristallographie
Zeitschr. physikal. Chemie
Zeitschr. prakt. Geologie [11]
Zeitschr. Vulkanologie
Zool.-bot. Gesell. Wien Verh.
Zool. Rec.
Zool. Soc. London Proc.

Some citations that involve difficulties are given below.

Unpublished reports: U. S. Geol. Survey Bull. 861 (in preparation). Use dash if no number has been assigned. If report has been sent to printer write "in press" instead of "in preparation." It is undesirable to cite a report to which a number has not been assigned or to cite a numbered report long in advance of its publication. Even a report that is "in press" may remain in that stage for several months before it is published. For manuscript reports that are not to be published use some such form as "(manuscript report in files of U. S. Geol. Survey)."

Chapters of the several series of "Contributions": U. S. Geol. Survey Bull. 849–A. [Give the letter designating the chapter, as well as the number.]

Congressional documents: 62d Cong., 1st sess., H. Doc. 341 [or S. Doc. 341].

Maryland Geol. Survey, Eocene, 1901.

U. S. Geol. and Geog. Survey Terr. Bull., vol. 1 [1st ser.], no. 1.

Powell, J. W., Report on the geology of the eastern portion of the Uinta Mountains, p. 156, U. S. Geol. and Geog. Survey Terr., 2d div., 1876.

Browne, J. R., Mineral resources of the States and Territories west of the Rocky Mountains for 1867. p. 10, 1868. [Give both dates.]

Raymond, R. W., Statistics of mines and mining in the States and Territories west of the Rocky Mountains for 1875, p. 10, 1877.

U. S. Dept. Agr., Bur. Soils, Field Operations, 1911, pp. 31–67, 1914.

U. S. Geol. and Geog. Survey Terr., Illustrations of Cretaceous and Tertiary plants.

Challenger Rept., Zoology, vol. 9.

Die fossile Flora Grönlands, Theil 1: Flora fossilis arctica, vol. 6, Abt. 2.

Ore deposits of the Western States (Lindgren volume), pp. —, Am. Inst. Min. Met. Eng., 1933.

Problems of petroleum geology (Sidney Powers memorial volume), pp. —, Am. Assoc. Petroleum Geologists, 1934.

For a paper by one author included in a volume by another author: White, David, The carbonaceous sediments, in Twenhofel, W. H., and others, Treatise on sedimentation, 2d ed., pp. 351–430, 1932.

The reports of the Harriman Alaska Expedition are entitled "Alaska" and should be cited according to the following model: Gilbert, G. K., Glaciers and glaciation: Alaska, vol. 3, Harriman Alaska Expedition, 1904.

[11] First nine volumes designated only by the date—"Jahrg. 1893", etc. Beginning in 1901 volumes numbered—"Jahrg. 10", etc.

The use of Latin terms in footnotes to avoid frequent repetition of titles is confined to "op. cit." and "idem." "Op. cit." may be used if the previous reference is not far away, provided there can be no doubt as to what work is cited. If two or more works by the same author have been cited previously it is necessary to repeat the reference, or, if one of the publications is cited many times, it may be sufficiently identified by repeating either the serial number of the publication, as "op. cit. (Bull. 770)", or one or more significant words of the title, as "op. cit. (Geochemistry)." However, for the reader's sake, "op. cit." should be used sparingly. "Idem" is used only for a second citation of the same work, immediately following the first, on the same page. "Idem" may represent all of the preceding citation except the page numbers, or it may be used to represent simply the journal just cited, the author and title being different. The forms "id.", "ibid.", "ibidem", and "loc. cit." are not used—not because they are not good Latin but for the sake of simplicity.

Footnotes to tables

For reference marks in a table superior figures ([1], [2], [3], etc.) are used. As the references begin with 1 in each table and are not renumbered, the reference marks should be written in the manuscript.

The reference mark in a table should be written immediately after the word or matter to which it relates if the matter is in a heading to a table, in a "box head", or in a reading column, and immediately before the matter to which it relates if the matter is in a number or figure column. The reference mark should be written between parentheses if it is unaccompanied by words or figures. (See example in table below.) Reference marks should be written in numerical order, beginning in the heading of the table, going across the box heads, continuing across the top line of the table proper, then going across each succeeding line from beginning to end. The footnotes should be written at the bottom of the table. If a table covers several pages the footnotes pertaining to each page should be written at the bottom of the page, except notes from reference marks in the heading or the box heads, which should be given only once. If a reference is repeated it should carry the same reference number throughout the table. A sample table is given below.

Graphite produced in 1910

Country	Quantity (short tons)	Value
United States [1]	3,618	$288,455
Ceylon	[2] 30,183	[2] 1,159,529
Chosen (Korea)	[4]	[5] 56,000

[1] Mines and quarries, pt. 4, p. 672, London, 1911.
[2] Figures show exports.
[3] Subject to correction.
[4] Statistics not available
[5] Approximate only.

Reports on mining districts

By G. F. Loughlin

General suggestions

Reports on mining districts differ considerably in scope. Professional papers on large, extensively developed districts, which involve a vast amount of detailed study, are the most comprehensive and should be authoritative sources of information on all branches of geology that are conspicuously represented in the districts. Reports on small or only slightly developed districts are necessarily based on much less comprehensive information, and reports on certain special features may be much more restricted in scope. No matter what the scope may be, however, the purpose of the report is economic, and all parts of it therefore should be focused on those features that may be of direct value in the development of the district described. Too many authors tend to give equal emphasis to all sections of the report. The detailed study essential to the more comprehensive reports is likely to disclose valuable information on the more fundamental branches of geology, and the treatment of this information calls for careful consideration. It may be so closely related to economic problems that rather full treatment of it is essential to its practical application, or it may be more appropriately presented as a separate paper and only summarized in the economic report.

The report as a whole, as well as its major divisions, should be planned to give the reader a general idea at the outset, so that he may more readily understand the detailed descriptions that follow and appreciate their bearing on the author's conclusions. Although the author is treating a technical subject, he should also bear in mind that many of his readers will not be geologists. He should therefore avoid unnecessary technical terms and endeavor to express himself in simple, plain English. Certain technical terms that have become well established in the district being described and certain general terms that cannot be avoided without much circumlocution may be appropriately used, but even these terms may need definitions for the benefit of readers not familiar with the district or with the science of geology. There is a tendency among authors who are writing their first reports to continue the practice of their student days and attempt to display their command of technical terms and flowery expressions, but such writing is likely to give the reader who seeks practical information the impression that the report is impractical and only of academic interest.

Subject order

General order.—More elaborate reports should be planned under the following main divisions: Introduction, geography, geology, and mineral or ore deposits, in that order. The order of treatment of other reports

depends somewhat upon their scope and object but ordinarily should follow the same plan so far as it is applicable to the facts presented. The author should carefully consider this order of treatment and should depart from it only for the sake of leading his readers in methodical fashion to a realization of the main economic contributions of the report. Any departures from the usual order of treatment should be explained either in the general introduction or in the introductory statements at the beginnings of the major parts of the report. Every report, whatever its scope, should be preceded by an abstract that outlines the basic facts and states the author's conclusions. (See pp. 43–45.)

Introduction.—The introduction may comprise a statement of the purpose of the investigation and the events leading up to it, the conditions under which the work was done, acknowledgment of cooperation and favors, a summary of previous work in the same field, and an annotated bibliography. It should call attention to the author's outstanding conclusions regarding local or regional problems or on the further development of current theories and to noteworthy differences between his conclusions and those expressed in earlier publications.

Geography.—The attention given to geography should depend upon the district studied. If the district is little known, relatively complete information on location, routes of approach, topography, climate, vegetation, and other geographic features may be justified; if it is well known and its geographic features have been adequately treated elsewhere, only a brief statement emphasizing those features that affect the local mining industry is necessary. The origin of topographic features, as they are the latest results of geologic processes, should generally not be treated until the geologic features have been described.

Geology.—The discussion of geology should describe the distribution, character, and composition of the original and altered facies of the different rock formations, in order of age, their structural relations, their influence on topographic development, and their economic aspects. Descriptions of the formations should be followed by a section on geologic structure that interprets the origin of the different structural features to the extent that information permits and points out the extent to which structure has controlled the distribution and form of intrusive igneous masses and the courses followed by ore-forming solutions. The interpretation of topographic features should follow, and the entire section on general geology may be appropriately concluded with a summary of the geologic history.

Ore deposits.—The part on mineral deposits should aim to present historical descriptive data that will aid the operators in appreciating the factors on which to plan both the more thorough development of opened ground and the extension of exploration both horizontally and downward, not only within their own properties, but in undeveloped areas. Its general order of subjects treated should be history and

production, general character and classification of deposits, mineralogy, description of each class of deposits, genesis of original deposits, processes of alteration and enrichment, practical applications, and detailed mine descriptions. This sequence may be changed if orderly presentation can be improved thereby.

In reports on the older and larger districts the part on ore deposits should contain an adequate history of discovery, mining and cultural development, and production. The amount of information on the leading districts may even entitle this history to equal rank with the parts on general geology and ore deposits; on the other hand, the information on small districts may be so scant that it will be most conveniently appended to the general introduction, where it will not break the thread of consistent geologic treatment. The review of production should cite the geologic, technologic, and economic conditions that have accounted for fluctuations or changes in the rate of production, and it should conclude by calling attention to information in subsequent sections that may have a bearing on ore reserves and future development.

The section on mineralogy should logically precede the general description and classification of the mineral deposits, for it is at least a partial basis for classification. The more elaborate reports have contained alphabetic lists of minerals with their chemical formulas, and if the number of minerals is great, such a list may be a convenient reference, but the author should consider whether it is any more than a duplication of headings to the mineral descriptions. There may be some difficulty in deciding how much information should be included in the section on mineralogy and how much in that on the ores. Conciseness and clarity of treatment should govern the decision. Where preference is given to the section on mineralogy, this section should contain adequate descriptions of (1) the different ore minerals, grouped according to (*a*) their principal metal contents and (*b*) their hypogene or supergene origin; (2) the gangue minerals, appropriately subdivided. Any significant features regarding temperature of deposition, effect on metallurgical processes, and other matters may be appropriately included, thereby increasing the practical value of the presentation. The section may end with a review of paragenesis, which may be largely a review of pertinent parts of the preceding description and which should serve as a basis for any discussion of the classification, origin, and zoning of ore deposits.

The description of the general character of the deposits should serve as an introduction to subsequent sections and should present any classification of deposits that the author may devise for convenience and clarity of description. Much has been written about the classification of mineral deposits, and most writers today favor a genetic classification when considering mineral deposits in general; but, as all the deposits of a mining district may fall within two or three subdivisions of such a classification, although they differ markedly in form, structure, and metal contents, a

special classification based on these differences is likely to be most practical in a report on the district. The order in this classification should be followed in the detailed description of each class and subclass.

Descriptions of the different classes and subclasses of ores or mineral deposits should follow, including distribution of the main deposits and the ore shoots in them, controlling geologic features, structural relations, processes of ore deposition, and related alteration or replacement of wall rock. If the classes of deposits are few they may all be conveniently described before their genesis is considered; but if they are too diversified for such simple treatment, the original or hypogene deposits may be described and their genesis considered before the altered or supergene ores and the processes of alteration are described.

The subject of rock alteration also may be so complex as to deserve a special section enumerating the processes of alteration which have been active at different and perhaps widely separated times and some of which have particular significance with respect to the distribution and origin of mineral deposits, whereas others have no such significance. The most appropriate position of a special section on rock alteration depends upon its contents. It may follow the treatment of intrusive rocks or may be more closely associated with the discussion of mineral deposition. The author in his discussions of alteration and genesis should recapitulate the essential facts brought out in the descriptions, show their bearing on the problems under consideration, and deduce such theoretical conclusions as they may warrant. If the descriptive matter has been properly focused on these problems and has brought out the significance of the different items, the reader will be so well prepared for these interpretive discussions that they may be brief and do little more than bring together and confirm the minor interpretations that have been made throughout the report.

The general part of the report should conclude with a section on practical applications in which the author points out how his work may aid in the development of ore bodies and the finding of new ones and expresses his conclusions regarding ore reserves and the economic future of the district.

The detailed descriptions of mines should contain as full information as is available on history, development, production, and geologic features of each mine and should be adequately illustrated. The general reader may have little interest in these detailed descriptions, but operators and others who may become interested in a mine even many years later will look to these detailed descriptions for information and may value them more than the general part of the report. Their preparation should not, therefore, be regarded as an irksome duty but as the preservation of important geologic records. The more nearly complete they are the better is the author's basis for his general conclusions; in fact, it is advisable to prepare rough drafts of the mine descriptions before completing

the general sections of the report, as this practice gives a strong appreciation of the practical significance of different geologic features and prepares the author for emphasizing these features throughout the report. Care should be taken that the final drafts of mine descriptions do not include or needlessly repeat data that properly belong in the general sections of the report.

Definitions

In former editions of "Suggestions to authors" considerable attention was given to definitions of terms pertaining to ore deposits. Some of these terms have been little used for several years, and as both such terms and terms in current use are defined in textbooks and treatises on mineral deposits and structural geology and in glossaries of mining terms, only a few comments regarding them need be made here.

There has been much published discussion on the term "ore", but no definition proposed has been entirely satisfactory, principally because there is so much diversity in the materials to which the term is generally applied that attempts at a strict definition involve quibbling over minor details. Most definitions stipulate that ore is a mineral or rock from which one or more metals may be profitably extracted, but some ores are so treated that only one or more compounds of metals, such as zinc oxide and vanadium oxide, can be extracted on a commercial scale; furthermore, a considerable amount of material called "ore" is unprofitably produced, although the metals or compounds extracted from it enter the metal market. These comments suffice to emphasize the futility of a meticulous attempt at strict definition. It is far more essential to explain the significance of the terms as used in the district under consideration and follow the usage consistently throughout the report. Such related terms as "mill ore", "metallized rock," and "protore" will help in descriptions.

The term "gangue" is restricted so far as possible to nonmetallic minerals that were deposited in openings or by replacement of wall rock, but as there is no sharp distinction between completely replaced and only moderately altered wall rock, this term also must be used with discretion. Clear descriptions will aim to avoid confusing usage of the term. It is not desirable to describe as gangue any metallic minerals of no economic value. They are more clearly designated "associated metallic minerals."

As the terms "vein" and "lode" or "lead" have been used synonymously in legal phraseology, the author's use of them should be made clear. In general "vein" should signify a mineral deposit that occupies a well-defined fissure, whereas "lode" should signify an assemblage of veins, veinlets, or stringers so closely spaced that they can be mined as a single ore body; but it may be difficult or at least impracticable to distinguish between a simple fissure filling and a deposit that has been

formed by the partial or complete replacement of a sheeted zone. The term "lode" has also been used to designate a group of veins in steplike arrangement, to which the term "vein zone" may be applied. It is consistent to use terms that correspond as closely as possible to those designating faults and fissures, such as "fissure zone" and "fissure system." The least confusing procedure under such conditions is to adopt local usage and to define terms accordingly; otherwise it is good practice to restrict the use of "vein" to deposits in or along well-defined fissures and to use "lode" in its original meaning of anything that leads the miner.

Distinction should be carefully made between the mineral deposit as a whole and the ore shoots within it, also between ore shoots and stopes. The terms "pitch length", "stope length", "breadth", and "width or thickness", adopted by Lindgren and Ransome in their Cripple Creek report, have proved very useful.

"Hypothermal", "mesothermal", and related terms, introduced by Lindgren in his classification of ore deposits, and "hypogene" and "supergene", introduced by Ransome, have proved very useful in technical discussions, as each expresses in one significant word what would otherwise require a phrase or clause; but, as understanding of the significance of these words depends upon the reader's acquaintance with technical literature, it may be desirable to give at least some parenthetical explanations for the benefit of those who have little academic interest in the science of ore deposits. It is impossible to treat a technical subject without some use of technical terms, and those terms that have been generally accepted and are consistently used in standard textbooks are especially entitled to use in reports on mining districts, with as many parenthetical explanations as seem advisable. It is also impossible to write a text that will be understood by everybody, but the simpler the language used the greater the number of readers who will understand it. Technically trained readers will not object to a clear presentation in simple words. It is enlightening to find out incidentally during the study of a district the extent to which appropriate technical terms are understood and to use them accordingly.

One valuable aid to clear presentation is the distinction between processes and the results of processes. Such terms as "mineralization", "replacement", "alteration", "silicification", and "impregnation" refer to processes and should not be used to describe aggregates of minerals produced by these processes. Mineralization is a general process that comprises several specific processes, such as fissure filling and replacement, and the different terms should be used with corresponding care. Such careless expressions as "mineralization can be seen in all the openings" or "these deposits are tabular quartzose replacements" make sloppy writing and arouse a suspicion of hasty work, if not of half-baked training. They are common in reports by self-made "experts." The

term "secondary enrichment" is strictly tautologic, as enrichment is by definition a secondary process. As enrichment, generally effected by descending meteoric water, may also be effected by rising solutions, the terms "supergene enrichment" and "hypogene enrichment" are both concise and valuable.

These comments serve to emphasize the opening suggestion that clear, simple language is essential in reports that are to be read by those who are not specialists in the subject. A good measure of an author's understanding of his subject is his ability to express it clearly in plain words. Such clear presentations will be appreciated not only by the layman but by fellow scientists.

Paleontologic matter

Some special features of style for systematic descriptions in paleontologic matter are set forth below.

In center headings it is desirable to use with the name the term "class", "order", "family", or "genus"—that is, any classific term of higher rank than species.

The name of the founder of a species should be given, even in his original description: *Cassidulus holmesi* Twitchell, n. sp.

The name of the founder of a genus or species should not be abbreviated: "*Cinnamomum affine* Lesquereux", not "Lesq." nor "Lx." Paleontology is world-wide in scope, and identification of authors is important and should not be made uncertain by abbreviation. A note from the Far East [12] is appropriate here:

> Names of authors cited in combination with systematic names should not be abbreviated. What seems clear to the writer may not be clear to the reader, especially in other countries. Even official lists of abbreviations can only be complete to the date of their publication, to say the best.

In headings, synonymies, and lists the name of a species should be followed by the name of its founder; if it has been transferred to another genus the founder's name should be enclosed in parentheses, and it is desirable to add the name of the author who transferred it: *Sequoia langsdorfii* (Brongniart) Heer was described as *Taxites langsdorfii* by Brongniart and transferred to *Sequoia* by Heer.

In synonymy it is not necessary to follow the author cited in capitalizing specific names. Citations should be given in the style prescribed on pages 16–30 for footnotes, except that in synonymy it is not customary to give the author's initials unless they are needed to distinguish two authors of the same name, and that titles of papers published in serials should not be given. In a footnote it is desirable to give both the title of the paper and the title of the serial (see p. 17); in synonymy the name of the species cited is an adequate clue for the reader, and it is not necessary to give the

[12] Krejci-Graf, Karl, Scientific nomenclature and the preparation of papers: Kwangtung and Kwangsi Geol. Survey Special Pub. 12, p. 116, 1932.

title of the paper. Titles of serials should be abbreviated; titles of independent works (whether in one or more volumes) should be given in full.

Synonymy should preferably be arranged in the style indicated below. The description by the founder of the species is cited first; next references to the species and genus as at present accepted, in chronologic order; next synonyms and misidentifications, also in chronologic order. No punctuation is used between the name of a species and the names of its founder and combiner. A period is used to separate these names from those of other authors cited. Notes as to geologic formation and locality should be run in with the reference, as indicated in the second from the last entry in the following sample synonymy:

Sequoia reichenbachi (Geinitz) Heer

Araucarites reichenbachi Geinitz, Charakteristik der Schichten und Petrefacten des sächsisch-böhmischen Kreidegebirges, pt. 3, p. 98, pl. 24, fig. 4, 1842.

Sequoia reichenbachi (Geinitz) Heer, Flora fossilis arctica, vol. 1, p. 83, figs. 1d, 2b, 5a, 1868.

Lesquereux, U. S. Geol. Survey Terr. Rept., vol. 6, p. 51, pl. 1, figs. 10–10b, 1874; U. S. Geol. Survey Mon. 17, p. 35, pl. 2, fig. 4, 1892.

Hollick, New York Acad. Sci. Trans., vol. 12, p. 30, pl. 1, fig. 18, 1892.

Newberry, U. S. Geol. Survey Mon. 26, p. 49, pl. 9, fig. 19, 1895 [1896].

Knowlton, U. S. Geol. Survey Mon. 32, pt. 2, p. 657, 1898.

Sequoia reichenbachi longifolia Fontaine, U. S. Geol. Survey Mon. 15, p. 244, pl. 27, fig. 8, 1890. Potomac formation, near Dutch Gap Canal and Fredericksburg, Va.

Sequoia couttsiae Heer. Hollick, New York Acad. Sci. Trans., vol. 12, p. 30, pl. 1, fig. 5, 1892.

?*Geinitzia reichenbachi* Hollick and Jeffrey, New York Bot. Garden Mem., vol. 3, p. 38, pl. 5, figs. 7–10, 1909.

The next to the last entry indicates the proper form for citing a misidentification. In the last entry the prefixed query indicates that *Geinitzia reichenbachi* is probably a synonym of *Sequoia reichenbachi* but that the point is not yet determined. Entries for homonyms and partial identifications are shown in the following examples:

Thinnfeldia variabilis Velenovsky [not Fontaine], Die Gymnospermen der böhmischen Kreideformation, p. 6, pl. 12, figs. 1–5; pl. 3, fig. 12, Prag, 1885.

Productus inflatus Tschernyschew [not McChesney]. Girty, U. S. Geol. Survey Prof. Paper 16, p. 359, pl. 3, figs. 1–1b, 2, 2a, 3, 1903.

cf. *Orthis callactis* Murchison [not Sowerby], Silurian system, p. 701, 1839.

Liriodendron simplex Newberry [part], Torrey Bot. Club Bull., vol. 14, p. 6, pl. 62, figs. 2–3 [not fig. 4], 1887.

It is also permissible to use the following form, which gives more specific information:

Thinnfeldia variabilis Velenovsky, Die Gymnospermen der böhmischen Kreideformation, p. 6, pl. 12, figs. 1–5; pl. 3, fig. 12, Prag, 1885. [Not *T. variabilis* Fontaine, 1889.]

Exceptionally it may be considered desirable to arrange a synonymy in strict chronologic order. If this plan is adopted it should be used throughout a report. The date is placed at the beginning of each entry instead of at the end, and the names of the genus, species, and founder are

repeated for each entry, but in other particulars the style indicated above should be followed. Sample entries for a chronologic synonymy are given below:

1888. *Fenestella tenax* Ulrich, Denison Univ., Sci. Lab., Bull., vol. 4, p. 71. Waverly group, Cuyahoga County, Ohio.

1895. *Fenestella tenax* Ulrich. Keyes, Missouri Geol. Survey, vol. 5, p. 24. (Date of imprint, 1894.) Kaskaskia limestone, Chester, Ill.

1903. *Fenestella* cf. *F. tenax* Ulrich. Girty, U. S. Geol. Survey Prof. Paper 16, p. 339. Hermosa formation, San Juan region, Colo.

1906. *Fenestella tenax* Ulrich. Ulrich, U. S. Geol. Survey Prof. Paper 36, p. 34, pl. 4, fig. 2d. St. Louis limestone, 4 miles northwest of Princeton, Ky.

1906. *Fenestella tenax* Ulrich. Cumings, Indiana Dept. Geology and Nat. Resources 30th Ann. Rept., for 1905, p. 1279, pl. 30, fig. 1; pl. 31, figs. 1–1b. Salem limestone, Bedford, Ind.

The English forms "n. gen.", "n. sp.", "n. var.", "s. s.", "not", "part", "of authors", "undet.", "position uncertain" are preferable to the Latin "gen. nov.", "sp. nov.", "var. nov.", "s. str.", "non", "pars", "auct.", "indet.", "incertae sedis."

The forms "*Orthis* cf. *O. umbraculum*" (not "*Orthis* cf. *umbraculum*") and "*Orthis* aff. *O. umbraculum*" should be used—that is, the initial of the generic name should be repeated. The first example means that the specific identity of the fossil is not known but that it resembles *Orthis umbraculum* (cf., confer, compare); the second means that it is related to but not identical with *O. umbraculum* (aff., affinis, related to).

The following example indicates the style to be used in a key to species:

Genus FICUS Linné

Broad leaves palmately veined:
- Very large:
  - Over 15 centimeters in width ..... *Ficus* sp.
  - Less than 15 centimeters in width ..... *Ficus neoplanicostata*
- Under 12 centimeters in width:
  - Primaries 5, basilar ..... *Ficus pseudopopulus*
  - Primaries 3, basilar ..... *Ficus harrisiana*
  - Primaries 3, suprabasilar:
    - Large leaves ..... *Ficus planicostata maxima*
    - Small leaves ..... *Ficus occidentalis*

Narrower and more elongated leaves with pinnate venation:
- Not over 7 centimeters wide:
  - Secondaries remote ..... *Ficus schimperi*
  - Secondaries closer ..... *Ficus denveriana*
- Over 7 centimeters wide:
  - Outline regular, secondaries numerous ..... *Ficus monodon*
  - Constricted medianly, secondaries remote ..... *Ficus vaughani*

In the text a generic name that has been used once may be cut down to the initial to avoid repeating in full, provided there can be no doubt as to the meaning. If two genera having the same initial have been mentioned the abbreviation may not be clear.

Names of genus and species are italicized, except in lists or tables; other names (family, class, or order) are printed in roman.

A query indicating doubtful reference or identification should follow (not precede) the part of the name to which the doubt relates. It should be written close to the name and should not be enclosed in parentheses: "*Martinia? glabra* Martin" means that the reference of the species to the cited genus is doubtful; "*Martinia glabra?*" or better "*Martinia glabra* Martin?" means that the identification of the species is doubtful but that the genus is certain. In lists, tables, and synonymy no punctuation mark should be used after a query at the end of a name; in text the matter should be punctuated as if the query were not there.

It is not necessary to insert in the text a footnote that would simply repeat a citation given in the synonymy, unless it is needed for clearness.

A plural formed by simply adding s to the Latin name is capitalized but not italicized: Rhynchonellas, Streptasters. The anglicized form of a Latin name is not capitalized: brachiopods, foraminifers.

Coined adjectives, such as "aviculoid," "limopteroid", and "modiolopsoid", are not capitalized.

The side heading "Description" is generally unnecessary and contravenes the suggestion as to character of headings given on page 6.

In lists of fossils the generic name should be repeated in full, or if that practice would involve much repetition the generic name may be given only with the first species, the others being indented, as indicated below. This style, if adopted, should be used throughout a report.

Myrcia worthenii (Lesquereux)
Nectandra lancifolia (Lesquereux)
    pseudocoriacea Berry
    puryearensis Berry
Nyssa eolignitica Berry
    wilcoxiana Berry
Oreodaphne obtusifolia Berry
    pseudoguianensis Berry
    puryearensis Berry
    wilcoxensis Berry
Oreopanax minor Berry
Osmanthus pedatus (Lesquereux)

In Latin names ae and oe should be printed invariably as two letters, without regard to the derivation of the name.

Unpublished or "nude" names (unaccompanied by a description) are invalid and should not be included in any paper, even though they are stated to be manuscript names, unless it is certain that a description in some other paper will be published before the paper in which it is desired to include them.

Reports on ground water

By O. E. Meinzer

Papers relating to ground water, like other technical productions, should be written in language that is precise and logical. A writer can use such language only if he has precise concepts and a logical train of thoughts to present. Technical papers that are difficult to understand are likely to have been written by authors who are incapable of precise and logical thought. The language should be as concise as practicable, in order that the reader need not waste mental effort in his endeavor to determine the facts and conclusions presented; but it should

not be so abbreviated or idiosyncratic as to call attention to the style. Every conclusion should be expressed accurately and completely, with explicit statement of the limitations of knowledge involved. This should be done regardless of the number of words and sentences required. However, when a conclusion has once been carefully expressed it should not, as a rule, be repeated in paraphrased form. Technical terms are an aid to both the technical and the lay reader, provided they represent precise and significant concepts that are involved in the subject matter covered, and provided the reader already has or is given accurate definitions of the terms. Only a quack will use technical terms to advertise his erudition.

Papers relating to ground water differ greatly in their subject matter and objectives, and therefore no general outline can be given that will be adapted to all papers. The areal reports, or papers that give systematic descriptions of the ground-water conditions in specified areas, should as a rule be divided into three parts, as follows: (1) General description of the area, including the geologic and ground-water conditions; (2) systematic description of each of the successive geologic formations in the area, including their water-bearing properties, and the quality of the water; (3) detailed descriptions of subareas, such as counties, townships, or geomorphic units. (For an example of a report with this arrangement see Water-Supply Paper 656.)

The outline for the general description will vary somewhat with the area to be described. Each author who is preparing to write an areal report should make a preliminary study of the tables of contents of Water-Supply Paper 656 and other areal reports that have been published or are with the editor. As a rule the general description should include an introduction and a general treatment of the geography, geology, and ground-water conditions. The text relating to the general geography and geology should be written for the purpose of giving an adequate background and foundation for effective presentation of the facts relating to the occurrence, source, quantity, quality, recovery, and utilization of the ground water. As a rule it should not be more elaborate than is necessary to accomplish this purpose. Some statement of pertinent hydrologic principles is also warranted, but extensive presentation of general principles should be avoided. In the course of an investigation valuable geologic or hydrologic results are frequently obtained which deserve publication but the details of which are not essential in the areal report. It is generally a question of judgment and expediency as to whether such material should be included in the areal report or presented in a separate publication. If the area has a considerable stratigraphic section, the general description should include a table of the geologic formations, with a column for succinct statements regarding the water-bearing properties and quality of water in each formation. (See Water-Supply Paper 656, pp. 18–21.)

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The systematic description of a stratigraphic unit should include the information that is usually given in geologic reports, such as distribution, thickness, lithology, age, and stratigraphic relations, insofar as the information is essential for effective treatment of the ground-water conditions. Detailed geologic data, such as lists of fossils collected, may be included in the systematic descriptions or published in a separate paper. The systematic descriptions should cover, in considerable detail, the water-bearing properties of the formations described and the head and quality of the water, including reference to significant well data. The data as to mechanical composition, porosity, moisture equivalent, and permeability can appropriately be presented in the systematic descriptions or given in tables at the end of the water-supply paper.

Detailed descriptions of subareas aid greatly in applying the facts and conclusions of the report to the determination of the ground-water conditions in specific localities. Much skill is required in preparing the reports on subareas to avoid repetition of general statements and to describe adequately the conditions in all parts of the subarea. The well records and logs, water-level records, and water analyses can advantageously be given in the reports on subareas, either in the text or in accompanying tables, or they may be presented in tables or notes at the end of the water-supply paper. Data given in the tables should not, as a rule, be repeated in the text. Likewise, well sections given in graphic form should not be duplicated in the form of well logs.

Illustrations accompanying water-supply papers are of two general types—those which present detailed information not given in the text, such as the detailed geologic and hydrologic maps; and those which illustrate or summarize, in pictorial or graphic form, information that is presented in detail in the text or tables.

Detailed maps are unavoidably more or less complicated. If a map is made to show data of several kinds it may become too complicated to be intelligible without excessive effort. In such circumstances the data should be presented on two or more detailed maps. By careful planning and avoidance of unnecessary colors, it may be less expensive to publish two or more relatively simple maps than to publish one complicated map that would show the same data. The legend of every geologic map should include a succinct explanation of the water-bearing properties of each stratigraphic unit shown on the map.

Diagrams based on detailed data published in the report can generally be justified only if they aid the reader in obtaining a perspective of the outstanding results of the investigation. They should therefore be carefully limited in number and invariably kept simple. Diagrams that illustrate only unimportant features or are too complicated to be readily understood are worse than useless, because they tax the time and energy of the reader without giving commensurate reward.

Every report that is prepared for publication as a water-supply paper or contribution to hydrology should include an abstract. (See below.) Great effort should be made to keep the abstract as brief as practicable and yet to have it give an adequate perspective of the subject matter covered and the results obtained. It should, if practicable, include a brief but accurate statement of the principal conclusions that are expressed in the report. It should not be a mere paraphrase of the table of contents. With the rapidly growing volume of technical literature, it is becoming increasingly desirable to publish abstracts that will in a few words give the reader the essence of the principal conclusions and will, moreover, indicate whether the report contains material relating to the reader's specific problems or interests that will justify further expenditure of his time.

Abstracts [13]

Purpose

For the author the abstract is an opportunity to bring what he considers the important results of his work before his colleagues in condensed form. For his colleagues it is a means of keeping in touch with a much larger field of scientific publication than they can otherwise cover. It also, by presenting a brief quotable summary of the report, helps the Survey to disseminate knowledge of its work.

An abstract should therefore be a concise but comprehensive summary of the significant contributions to knowledge contained in a report. It should also be in a broad sense a guide to the contents of the report, adequate to serve as a basis in the preparation of general indexes to geologic literature. Therefore it should bring out not only the major contributions related to the main subject of the report but also any important incidental contributions to which the title gives no clue. Although the conclusions arrived at are the most valuable part of a scientific contribution, yet the author should realize that few of his colleagues will have time to read his paper in full, and he should indicate, as far as necessary, the method of attack and the type of data used.

Content

As the abstract may be used in an abstract journal it should be independent of the table of contents and not a mere expansion of it.

The abstract should clearly orient the paper in place, in geologic time, and in function, but it should supplement, not duplicate the title in this respect.

A systematic grouping of facts is desirable, and in the abstract of a large report headings may be used.

If local stratigraphic names are used, a statement of their place in the general geologic column, as nearly as it is known, should be included.

[13] Revised from suggestions prepared by a committee of the geologic branch.

Examples should not be used to amplify statements.

Comparisons with the work of others or with what has been previously known about a topic should be avoided. This does not exclude reference to the work of others if the present work is a development from theirs and it is necessary to show the basis on which it is built.

Be as specific on each point as space allows. Do not state what the report is about but what it tells. For example:

Do not say, "Not all the primary minerals are detrital; some are probably formed in place." Say, "Not all the primary minerals are detrital; at least a part of the iron carbonate, titanite, and feldspars have been formed in place."

Do not say, "There were several periods of elevation and erosion." If doubtful say, "The region has been elevated and eroded at least twice and possibly five times."

Do not say, "Subsequent movement along old faults indicates * * *." Say, "Pleistocene movement along the late Mesozoic faults indicates * * *."

Do not say, "From the character of the sand grains it seems that the sandstone is eolian." Say, for example, "From the roundness, predominance of 0.5-millimeter grains, and freedom from flaws of the quartz grains it seems * * *."

Abstracts of paleontologic papers, which are partly in the nature of catalogs, require special consideration. New family and generic names should probably be mentioned, and the number of new species in different groups indicated. The proportionate distribution of fossils in the different groups should probably also be given. In other respects the abstract should follow the usual plan.

Length

It is impossible to assign definite lengths to abstracts. In general, short, compact papers require actually shorter but proportionately longer abstracts than long, detailed ones. Many Survey publications are areal reports that consist of a series of nearly independent papers, and it is therefore especially desirable that abstracts of these should bring out all the significant results, which may be hidden under the regional title. The Revue de géologie sets very low limits—not more than 125 words for a 5-page article, 250 words for a 25-page article, and 1,200 words for the longest reports. Biologic Abstracts sets the upper limit at 3 percent of the length of the original paper. The abstracts in Astrophysical Journal and Physical Review and those from anthropologic articles average about 5 percent. Those in Chemical Abstracts average considerably less, but they are of a different character from what is contemplated here. Probably 3 percent is a reasonable maximum limit for a short paper, and 2 printed pages of small type (1,500 words for a bulletin or water-supply paper; 3,000 words for a professional paper) for a long paper.

References

Some articles on the functions and methods of abstracting that may prove useful are cited below.

Fulcher, G. S., Scientific abstracting: Science, new ser., vol. 54, pp. 291–295, 1921; The usefulness of analytic abstracts: Idem, vol. 56, pp. 678–680, 1922; Indexing of scientific articles: Nat. Research Council, Reprint and Circ. ser., no. 34, 1922.

Schramm, J. R., The abstracting and indexing of biological literature: Science, new ser., vol. 56, pp. 495–501, 1922.

Jenks, A. E., A suggestion for abstracts of anthropological literature: Idem, vol. 60, pp. 73–76, 1924.

The best guide, however, is a study of published geologic abstracts. Good examples, chosen at random from Survey publications, are in Bulletins 771, 787, 795–A, and Professional Paper 135. Other good abstracts of Survey reports are given in the Journal of the Washington Academy of Sciences, volumes 1–11, 1911–21, and of Survey water-supply papers in Revue de géologie.

Illustrations

Publications of any class may be illustrated, but illustrations may not be used for mere embellishment; each one should serve a definite scientific or practical purpose and should illustrate some feature described in the text.

Drawings and photographs intended for use as illustrations should not be inserted in the manuscript but should be kept in a separate envelope or package, and the material for all the illustrations for a report should be submitted at one time, with the text. The letter of transmittal accompanying the text should mention the illustrations and state their total number. The package of illustrations should contain a carbon copy of the list that forms part of the text, with manuscript page numbers. (See specimen list of illustrations on p. 5.) Illustrations on which geologic names are used should be submitted to the Survey's committee on geologic names, with the text, before the manuscript is transmitted to the Director.

The author and the chief of the branch transmitting the report are primarily responsible for the selection of illustrative material, but after the manuscript has been approved for publication by the Director the illustrations submitted are scrutinized by the administrative geologist, who rejects any that are unsuitable for reproduction or that seem unessential in view of the necessity for economy and approves the rest for preparation by the draftsmen. The chief illustrator decides the technical questions relating to the preparation of the illustrations. He is ready to advise the author at any stage but will not receive illustrations for final preparation in advance of approval of the complete report by the Director.

The illustrations are classified into plates and figures. Colored maps, line drawings larger than a full page, and generally reproductions of photographs will be made plates; other line drawings will be made figures. Figures are printed with the text; plates are, as a rule, printed separately from the text and are bound into the book at appropriate places or, if so large as to require several folds, put in a pocket at the end of the book. To save expense in binding, plates that do not go in a pocket are usually inserted at the end or in the middle of a "signature" (16 pages), and several plates may be inserted at one place.

The author should give each illustration a distinctive number—plates in one series, figures in another. The numbers should be assigned in the order in which references to the illustrations appear in the text. It should be noted, however, that an incidental mention of an illustration need not determine its number, which should be governed by the place where it is principally mentioned or discussed.

The number originally assigned should be kept, no matter what rearrangement, addition, substitution, or elimination may be made after the manuscript is typed. The final numbering of illustrations is determined by the chief illustrator and editor after the finished drawings, etc., are made, and as a rule it then becomes necessary to make some change in the author's numbering. For example, what the author has listed as a plate may prove to be susceptible of reduction to the size of a figure, or what the author has listed as a figure may have to be made larger than a page and hence become a plate. Any such change, of course, affects the numbers of all succeeding plates and figures. It is wasted labor for the author to attempt any change before the final numbers are determined; moreover, such an attempt may lead to confusion if one or more references in the manuscript are inadvertently overlooked. If new illustrations are added after the first numbering they may be designated temporarily by fractions, as "14½." If illustrations are eliminated their numbers may be omitted in the author's list. If an illustration is shifted from its original place, the appropriate change in the manuscript page number in the list of illustrations is all that is necessary to serve as a guide in the final numbering.

The author should not leave references to illustrations blank because of the possibility that his numbers may be changed in the final numbering. It is necessary for the editor who inserts the final numbers to know which illustration is being cited, and if the number is left blank he may have to guess, and his guess may be wrong. It makes no difference, for example, whether the author's original number is 7 or 700 if the editor knows that that is the particular illustration to be finally numbered 17.

Plates are numbered in arabic (1, 2, 3, etc.). If two or more subjects are combined to make a single plate they should generally be designated by italic capitals, as "plate 4, *A*"; but in plates showing a group of

fossils the individual subjects are numbered in arabic and called "figures", as "plate 4, figure 7." For details of a single subject that are too long to be lettered directly on the plate, italic lower-case letters (*a*, *b*, *c*, etc., or initials, as *q*, for quartz; *g*, for galena; *cp*, for chalcopyrite) are used and the explanation is given in the plate description.

In grouping photographs for reproduction as a plate the author should consider the appearance of the group as a whole; for example, a larger or darker photograph should be placed below a smaller or lighter one. Each group of this kind should, as far as possible, be made up of illustrations that are mentioned or described at nearly the same place in the report, in conformity with the rule that illustrations should appear in the order in which they are described.

If it is necessary to indicate that a photograph or photomicrograph has been enlarged or reduced in the reproduction the notation will be placed on the finished illustration itself, preferably at the lower right corner, in the form "× 87" or "× ½." The author should include this information in his title, however, and not on the photograph, as the chief illustrator may find it necessary to reduce the photograph slightly for reproduction, and in that event the enlargement on the printed plate will differ from that on the photograph. The correct scale will be computed in the section of illustrations from the information furnished by the author.

Full descriptions of the plates should be furnished if the brief titles given in the list of illustrations are not sufficient. It is desirable that the full descriptions be attached to the illustrations, especially photographs, as the length of the description may govern the amount of reduction necessary to bring an illustration within the page limits, but a separate list comprising the full descriptions should always be furnished, and a carbon of this list may be cut apart for attachment to the illustrations. The descriptions should, if possible, be kept short enough to be printed on the plates themselves. For example, on a plate showing fossils it is usually sufficient to give the name of each subject with a reference to the page on which it is described, as "3. *Sequoia concinna* Heer (p. 57)." Descriptions that are too long to be printed on the plates must be printed on facing pages, which adds to the expense. Such long descriptions can sometimes be avoided by incorporating the details in the text, but if unavoidable they should be inserted in the manuscript at the proper places, the description of each plate written on a separate page. Otherwise the titles of plates should not be written in the text, as they are set up at a different time.

Figures are numbered in arabic (1, 2, 3, etc.); details of a figure are lettered in lower-case italic (*a*, *b*, *c*, etc.). Symbols or letters that are used on the figures must be explained, preferably in the titles, but if the explanation is long and complex it may be incorporated in the text. The titles of the figures, including all necessary explanations, are set up at the same time as the text and therefore should be written in the manuscript at the places where the figures are to appear.

The original drawing for a line illustration should be larger than the illustration as it will be printed in the report. Most illustrations can be advantageously drawn for a linear reduction to one-half or one-fourth—that is, the distance between any two points in a drawing may be twice to four times the distance between the corresponding points in the printed illustration. The size of the printed page in bulletins and water-supply papers is 4⅜ by 7½ inches, in monographs and professional papers 7⅛ by 9⅛ inches. These dimensions include the space allowed for the page heading and the title of a text figure. Monographs and professional papers are printed two columns to a page; the width of a single column is 3⅞ inches. Plates to be folded may exceed these limits, but text figures and as a rule halftone reproductions of photographs should be no wider than the text page or column and enough shorter (or, if the title is to be printed the long way of the page, enough narrower) to leave room for the full title, as explained above.

Before an author prepares the material for illustrations he should confer with the chief illustrator concerning details of the work, especially with respect to maps. It is desirable that the base map used be the best that is available for the purpose. A map crowded with detail should not be used if the needs of the report require that only the principal features of the region be shown, and as a general rule the latest map available should be selected; any necessary details that it does not show can be added to it.

Authors should not attempt to make finished drawings, as that is the work assigned to the section of illustrations. Every care should be taken, however, to furnish clear copy, so that the draftsmen need not be in doubt as to any details.

Written explanations of all illustrations are also desirable. Too much of the time employed by draftsmen in making final drawings is consumed in interpreting uncertain features shown in crude original drawings. Authors can prevent this loss of time by adding to their drawings explanations of features that may be difficult or doubtful of interpretation. These explanations will also be useful when the author cannot conveniently be consulted, and they may be the means of avoiding long delays incident to correspondence.

Each piece of copy for illustrations should be plainly marked with the number assigned by the author. Each photograph should also be marked to show its source, as, for example, with the number of the negative in the Survey's collection or with the name and address of the photographer.

Every map, whether compiled from other maps or prepared by means of a special survey, should show the sources of all the data it embodies, including the names of the surveyors and the date of the survey. If it is prepared under a cooperative agreement it should bear the name of the cooperating State or organization.

Written permission to reproduce a copyrighted illustration must be obtained from the owner of the copyright, and the description of the illustration must contain the note "Copyright by ———; used by permission."

The completed drawings for the illustrations of a report will be submitted for approval or correction to the author, who should indicate his approval by signature. If corrections are necessary he should indicate them clearly on the illustration or on a memorandum to be attached.

Proofs of illustrations will be sent to authors when they can be reached without causing much delay in publication. Approval should be indicated by signature, and the proofs should be returned promptly. If corrections are necessary they should be clearly marked in ink on the proofs. Changes involving alterations from copy cannot be made at this time unless they are of great importance or are necessary to correct conspicuous errors, and such changes cannot be permitted without the consent of the administrative geologist. Even slight alterations at this stage may make reengraving necessary. Engraved plates can generally be altered only by cutting off lines or other features; no considerable additions can be made.

The original cuts of illustrations used in Survey reports are preserved for a few years and can be used again during that period. An author who may desire to use any such illustration should give its number and the number of the report in which it appeared. Electrotypes of illustrations cannot be obtained for use in unofficial publications, but if the original drawings or photographs are still available in the Survey files they may be borrowed by an author for reengraving, after approval of the request by the administrative geologist.

Suggestions as to expression

"Writing maketh an exact man. He who writes little had need have a good memory."—Bacon.

General counsel

An eminent critic has said that the ideal of literary style is "the speech of the people in the mouth of the scholar", but this ideal cannot be consistently maintained throughout a series of reports that are in large part technical. Some of the reports of the United States Geological Survey are technical contributions to that universal encyclopedia that is being compiled by scientific men in all parts of the world. Of the immediate or ultimate practical utility of much of this material there can be no question, but a part of it is of necessity unintelligible to the ordinary reader. Many of the Survey's reports, however, such as those on placer mining, coal beds, or water-bearing beds, may be written in a simple and somewhat popular style, and simplicity and clearness in both technical and untechnical matter may profitably be cultivated by all writers.

The following extracts from an article written by a former Director of the Survey[14] are suggestive and highly significant:

[14] Smith, G. O., Plain writing: Science, new ser., vol. 42, pp. 630–632, Nov. 5, 1915.

At its best, science is simple; for science is not much more than arranging facts so as to set forth the truth. Scientific thought is exact and direct, and scientific writing must therefore be accurate and to the point. The scientist should think directly and with the precision of one of the instruments of his trade, and above all his language must present that thought exactly. * * *

Of course, any writer's first duty is to be intelligible. Choice of language thus resolves itself largely into an understanding of the audience. If a scientific investigator desires to announce his discovery to his fellow workers, he does well to use those exact terms that carry the same shade of meaning the world over and indeed may have the same form in several languages; if, on the other hand, his results have immediate value for the mine operator or the prospector, the geologist does not and cannot accomplish his purpose unless he writes in plain language, using words possibly less exact but surely more understandable. * * *

It is not a coincidence that some of the deepest thinkers in geological science have also possessed a literary style conspicuous for clarity of expression. On the other hand, some authors whose English needs the most editing are equally careless in the quotation of facts determined by others and, indeed, in the statement of their own observations. I mention this simply to show that I am strong in my belief that plain writing is not something beneath the plane of endeavor of the scientific investigator—indeed, it is something so hard to attain that the most of us need to aim high, to raise our standards of scientific thinking. The use of common words is worthy of any writer if his purpose is to transmit thought.

In a later article [15] Dr. Smith wrote:

The geology I plead for is that which states facts in plain words—in language understood by the many rather than only by the few. Plain geology needs little defining, and I may state my case best by trying to set forth the reasons why we have strayed so far away from the simple type.

First of all, I suppose we may as well admit a certain liking for the sound of words, and the longer the word the more sound it has. Especially enjoyable is this mild form of hypnotism if both ideas and words are such as to make us feel that we are moving in the highest circles. At the meeting of the British Association this year one physicist frankly explained that the idea of relativity is popular because to most people it is "pleasantly incomprehensible." * * *

Again, I fear lest in our writing we lose sight of our audience, if, indeed, some of us ever see at all the audience to whom we address our written reports. The chief purpose of words is to convey thoughts, and unless the wave lengths of the words are right the receiving apparatus will utterly fail to pick up the thoughts. * * *

This brings me to a third reason for our use of highly technical language: we too often try to overdress our thoughts. Just as there is a somewhat prevalent notion that clothes make the man, so we subconsciously believe that words make the idea. We follow the precept "To be scientific, use scientific terms", and in so doing we deceive ourselves. I do not wish to be unduly autobiographic in this analysis, but to show my true sympathy for those whose practices I denounce, I confess that I, too, have had the unhappy experience of stripping the technical words from what looked like a good-sized geological deduction only to find that the naked idea was rather small and not my own. It is also a common experience to make the sad discovery that a piece of involved and obscure writing is simply the product of roundabout reasoning or twisted thinking. Our own words fool us, and unconsciously we cover up with long words or tangled rhetoric our lack of plain thinking. * * *

There is really somewhat of an obligation upon us, both as scientists and as partners in the world's business, to show the world that geology is not mystery or magic but only

[15] Smith, G. O., Plain geology: Econ. Geology, vol. 17, pp. 34–39, 1922.

common sense. I have told practical men of business that they should give little credence to the geologist who cannot tell his story in common language. The world has a right to discount our usefulness and even to distrust our honesty if we persist in concealing our thoughts, or lack of thoughts, behind a mask of professional jargon.

Much of the popular ridicule excited by some scientific reports is justly chargeable to the authors' indifference and neglect in the matter of expression. An eminent critic,[16] who is also a man of science, writes:

> It is strange that scientific men who habitually work in dimensions of a ten-thousandth of an inch are either blind to gross confusions of argument and to false refractions of meaning or regard them with indifference. * * * A writer who wishes to convince must lay his mind alongside that of the reader, who must be carried along in a quick and equable current.

Another English critic [17] says:

> You must first be your own reader, chiseling out the thought definitely for yourself, and after that must carve out the intaglio yet more sharply and neatly, if you would impress its image accurately upon the wax of other men's minds.

An English instructor in a New York City college said recently, "Clarity is not infantile, nor is complex opacity profound."

If judged by their literary merit many scientific papers would not deserve publication; only the facts they relate give them value; but unless the facts are stated plainly, in proper order, and with skill to carry conviction the purpose of their publication will not be achieved.

Most of the masters of literature devoted great time and care to the task of writing and rewriting their works. The labor of correction and revision that Fontaine gave to his fables is almost incredible. Buffon rewrote his matter several times and then had it read aloud to him, that he might note where the reader halted or failed to catch the meaning at once, and revised or rewrote accordingly. Macaulay repeatedly rewrote and revised his manuscript, and Robert Louis Stevenson, one of the masters of modern English, who devoted a large part of his life to the study of style, revised and polished his matter until his critical fancy was fully satisfied. The writers of the Geological Survey's reports are not so fortunate in having the privilege of thoroughly revising their manuscripts; the demand for the printed results of their scientific work is immediate and insistent, and the transition from field notes and sketches to finished maps and drawings and complete manuscripts, ready for printing, must be made in the shortest time possible. It is true that the manuscript is read critically by the Survey's editorial staff, but the editorial work is done under the same stress and is necessarily somewhat superficial. Many of the refinements of style that characterize the best literature therefore cannot reasonably be expected in a Government scientific report, where the chief object should be precision or clearness of statement.

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[16] Allbutt, Clifford, Notes on the composition of scientific papers, 2d ed., p. 30, 1905.

[17] Quiller-Couch, Arthur, On the art of writing, p. 162, 1916.

Adams Sherman Hill,[18] professor of rhetoric at Harvard University from 1876 to 1904 and afterward professor emeritus, gives the three following rules for good writing:

1. The rule of precision: Of two forms of expression which may be used in the same sense that one should be chosen which is susceptible of but one interpretation. Observance of this rule tends to give each word a meaning of its own.
2. The rule of simplicity: Of two forms of expression which may be used in the same sense the simpler should be chosen. The simpler a word or phrase the more likely it is to be understood, and simplicity in language, like simplicity in dress or manners, belongs to the best society.
3. The rule of euphony: Of two forms of expression which may be used in the same sense that one should be chosen which is the more agreeable to the ear. It is of course wrong to give undue weight to considerations of euphony, but when no sacrifice is involved it is desirable to avoid an expression that is unusually difficult to pronounce or to substitute for an extremely disagreeable word one that is agreeable to the ear.

Correctness, clearness, and conciseness are ideal qualities of good scientific writing. Clearness alone is not sufficient, for a statement that is entirely clear may contain grammatical errors or may be expressed in terms that are not well adapted to a scientific report; and conciseness may be gained at the expense of both clearness and correctness. However, all abstract good counsel as to forms of expression is suggestive only, and its ready acceptance by a writer does not imply that he has the detailed knowledge or the skill to apply it in practice; and without that knowledge and skill all faith in good rhetorical doctrine becomes "faith without works."

The technical student's need of better training in English has been recognized by many professional and scientific men. In his preliminary analysis of replies received from 23,000 circular letters sent to engineers to ascertain the needs of the profession Dr. Mann,[19] of the Carnegie Foundation for the Advancement of Teaching, wrote:

In questioning the efficiency of the engineering schools at the present time there are four conspicuous things in which the professional men show a fair degree of unanimity. The first and most important is English. A large majority of the letters received mention the absolute necessity for higher efficiency in the training in English.

In a lecture on the teaching of English at the universities Sir Stanley Leathers said:

Education without English is like the wisdom of the dumb: it lacks the one thing which gives outward value to the whole. And what sort of professional training is that which has not made the man fit to put his meaning on paper that others can grasp and respect it?

Fortunately for the scientific writer the reader expects far less from him than from the writer of "polite literature", whether of prose or poetry. He looks for no feats of imagination, no flights of fancy, no rhyme or rhythm, and few rhetorical figures of any kind—the fewer the

[18] Hill, A. S., The principles of rhetoric, pp. 18–22, 1895.

[19] Mann, C. R., Soc. Promotion Eng. Education Bull., vol. 6, p. 100, October 1915.

better. All he asks is a plain description of something seen or inferred—of observations or experiments made and conclusions reached—and the plainer the tale the better he will like it. But this ideal simplicity is hard to attain. A French master of style [20] writes:

> A simple style is like white light. It is complex, but not to outward seeming. In language a beautiful and desirable simplicity is but an appearance, and it results only from the good order and sovereign economy of the various parts of speech.

Economy and efficiency in expression may well be studied by the man of science, not only for his own credit but in the interest of science itself.

The dictionaries must be used with vivid realization that as a rule they do not and cannot prescribe usage—they only record it, and they record both good and bad usage. One of the few scientific men who have also undertaken literary criticism [21] writes:

> Certain critics have argued that as such and such a use, which I deprecate, is quoted by the New English Dictionary therefore the use is justified against me. I suspect that no one would be more taken aback by such a protest than the editor of that great work. A dictionary may give select uses or all uses; the editor of the New English Dictionary decided—wisely, in my opinion—to give all uses and to leave to the inquirer the advantage of comparing them and their sources for himself. The dictionary "sanctions" nothing of its contents, but it enables us by consultation of its stores to compare and choose for ourselves. In using this liberty we shall neither be subservient to the prescriptions of age nor scornful of modern freedom; in every use we shall be guided by historical growth, the example of the best authors, and our present necessities.

The scientific writer, above all others, should choose words that have precise meanings or to which precise meanings may be given. He knows how dictionaries are made—he may have helped to make them—and he should use them with discrimination and never forget that English is a live and growing language.

Probably every writer in the Survey has been put through the usual course in rhetoric and has learned some of the elementary principles of writing; he has been taught, for example, that the emphatic phrase or word should stand at the beginning or, better, at the end of the sentence, and that emphasis may also be gained by other devices, but the reports of many an author display here and there not his schoolboy knowledge but his adult forgetfulness of the elements of force in expression. So much of that earlier study was fruitless of practical results that many of its supposed lessons might be forgotten without serious loss. Thorough studies of Chaucer, of the obsolete style of the Spectator or of the sounding periods of Burke's address on conciliation with the Colonies are doubtless valuable, but if long continued they diminish the time available for the study and practice of present-day English—the sort of English that should be used by the author of a report on mineral deposits or geologic structure and processes.

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[20] France, Anatole, On life and letters, trans. by A. W. Evans, 1914.

[21] Allbutt, Clifford, Notes on the composition of scientific papers, 2d ed., pp. x–xi, 1905

If the author wishes his message to have its best chance of being effective, it is well worth his while to burden himself with all the labor of making it clear and forceful. The author's perspiration will lead to the reader's inspiration.

First or third person

An author should determine at the outset of his work on a report whether he will write it in the first or in the third person. Both "I" and "the writer" should not be used indiscriminately. The first person is more straightforward than the third and if not overused is no less modest or becoming; moreover, it prevents the ambiguity that may occasionally arise where "the writer" may be taken to refer to some other writer who has just been mentioned, as in the following example:

These analyses, according to a letter received from Mr. Ellicott, were made * * *
Though the samples analyzed were collected from localities unknown to the writer * * *

Order within the sentence

Essentials of a good sentence

An adequate vocabulary and a keen discrimination of the best meanings and proper uses of words are essential to all good writing, but still more essential is the ability to arrange words properly in sentences that will convey at once, clearly and forcefully, the ideas to be expressed. Among the indispensable requisites are the choice of the best subject nominative, the determination of its proper place, and the selection of an effective closing phrase or word. Other points that must be considered are consistency of construction, relation of all parts of the sentence to the subject nominative, and continuity of thought. Order of statement or of arrangement is of primary importance, and related words and phrases should be kept together. The obvious lack of proper order in the following example is corrected in the rewritten sentence:

His interpretation differs from that of the writer for the ancient glaciation of the region here described in several particulars. (His interpretation of the ancient glaciation of the region here described differs in several particulars from that of the writer [or from mine].)

Brevity is, of course, always desirable, but brevity should not be gained at the expense of clearness or correctness. The following sentence of 130 words shows not only lack of brevity but numerous other faults. The labor of untangling such a muddle of ideas should have been assumed by the author before he submitted his manuscript for publication.

The view, looking west, shows a portion of the Park City mining district and in the distant background a peak, Clayton (elevation 10,728), formed by an extensive stock of diorite, cutting and metamorphosing sediments adjoining on north as the argillite composed Jupiter Peak which are traversed by master northeast fissures carrving extensive veins of valuable silver-lead ore as the Crescent vein on Crescent Ridge; which faults Jurassic down 1,000 feet against Triassic; and in near foreground a ridge marking a major overthrust fault, overriding two formations; and in immediate foreground the mouth of

Ontario tunnel (5 mi. in length) of Ontario mine, which produced, between 1872 and 1896 silver-lead ores which yielded over $60,000,000 worth of silver, surrounded by the plant of the Park Utah Consolidated Mining Co.

Sentences badly begun

Some writers unconsciously get into the habit of beginning sentences with "there is", "there are", "it is"—a trick of construction that may not only multiply words but may have the effect of putting in an inferior place a subject nominative that should preferably stand at or near the beginning of the sentence. "There is no quartz in the ash and it is probably andesitic in composition" could be profitably rewritten "The ash contains no quartz and is probably andesitic", with 9 words instead of 14 and with a gain in force and clearness. Some other sentences of this kind are corrected below.[22]

There are many other primary minerals contain*ing* phosphorus.

There are [At] some places *where* lignite beds are exposed. (Beds of lignite are exposed at some places.)

There has been some faulting [occurred] subsequent to the deposition of the ore.

It is believed that these vugs probably represent openings *which were* formed by recent faulting.

It is the belief of the miners [believe] that the ground now worked may be a slide.

There is a probability that some of the veins may have had their gold content increased by enrichment. (Better: The gold content of some of the veins may have been increased by enrichment.)

"There is some stibnite in the ore" is not so good as "The ore contains some stibnite": the second sentence is not only briefer than the first but more normal and more forcible; it begins with a concrete term, the proper subject, and it ends with the term that should stand at the end of the sentence, in the place of superior emphasis.

"There is little direct evidence from outcrops of the faulting" was written to mean "The outcrops afford little direct evidence of the faulting." "There is also a difference in the grade of the valleys" was replaced with advantage by "The valleys differ also in grade", for the context showed that "grade" was the term to be emphasized.

An initial "there is" or "there are" may also undesirably detach a sentence from one that precedes it, as in the following example: "The Niagara is mainly a light-gray to light-buff fine- to medium-grained dolomite. *There are* [It contains] both thick and thin beds, and at certain horizons *there is* considerable chert."

The phrases "There are", "There were", "There have been", "It is", "It was", etc., may, of course, properly and preferably begin many sentences, but the writer who is about to use one of these phrases should consider whether he cannot express his thought more forcibly in some other way.

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[22] Corrections in the examples quoted in this pamphlet are indicated by italicizing the words that should be omitted and placing in brackets the words that should be added.

Wrong subject nominative

The sentences quoted below show mischoice of subject nominative, with consequent wordiness and lack of clearness and force.

The principal use of sheet mica is *in the manufacture of* [used principally in making] electrical apparatus.

The *drainage of the* area is *accomplished* [drained] by three streams.

The principal production [Most of the ore produced] was mined from the Nevada property.

The *exploration of the* region was *carried out* [explored] by Smith.

During this epoch *aggradation of* the lowlands may have *transpired* [been aggraded].

Thus *a sudden inundation of* the desert would be *accomplished* [suddenly inundated].

The *movement of the* ore solutions here must have *been* [moved] very slow[ly] or [have remained] practically stagnant.

The *formation of the* ore deposits *occurred* [were formed] just after the igneous intrusions.

Confirmation of these reports cannot be *obtained* [confirmed].

The selection, equipment, and maintenance of stream-gaging stations are *performed* [selected, equipped, and maintained] according to standard methods.

The writers of these sentences, having "used up their verbs" in their subject nominatives, could find no suitable predicate verbs and were compelled to resort to weak, clumsy, or inappropriate substitutes, such as "occurred", "accomplished", or "transpired."

A writer should consider whether an abstract or a concrete term will form the best subject nominative of the sentence he is writing, and also which one will permit the choice of a suitable predicate verb. The sentences quoted above have been corrected by the use of concrete instead of more or less abstract terms as subject nominatives.

In the sentence "Barite and intense silicification usually always accompany the ore" the compound subject nominative links together a mineral, which could accompany the ore, and a process, which was ended long ago: it is the product of that process that accompanies the ore. Change "intense silicification" to "intensely silicified rock." Whatever idea the writer may have had in mind by his "usually always", the expression is objectionable, and probably the conditions will be adequately described if "always" is omitted.

Forgetfulness of subject nominative

Some writers seem to forget their subject nominative before they finish the sentence.

Its flow is large and is reported to be excellent for drinking. (The flow [of the spring] is so many gallons a minute; it is the water, not the flow, that is excellent.)

The "rim rock", which surrounds Billings, Park City, and the intermediate area, is the popular designation for this scarp. (A "designation" cannot surround an area. There is more than one way to correct this sentence, but it might well be rewritten "This scarp, which surrounds * * *, is popularly called the 'rim rock.' ")

The average thickness of the shale partings is about 1 millimeter but is extremely variable. (How could an average be variable? Write "The thickness * * * averages about 1 millimeter but is extremely variable.")

Although the rock has been greatly altered by weathering, the decomposition is believed rather superficial and is regarded as affording entirely adequate foundations. (Decomposition seems hardly an "adequate" foundation for a dam.)

The length of the shell is only about one-fourth or one-fifth longer than high. (Omit "length of the.")

The principal granite district of this group of States is at Salida, Chaffee County, and is sold for monumental stone. (The granite, not the district, is sold.)

Since the World War the French deposits have been largely Government-owned and have been sold through the German-French cartel. (It is the potash obtained from the deposits that has been sold, not the deposits.)

Modified subject nominative wrongly carried along

A phrase that qualifies or relates to the subject nominative applies until a new subject nominative is introduced, but in many sentences such a phrase is "carried along" to a part of the sentence to which it does not apply.

For full development the tree seems to require considerable water and probably deserves its reputation as an indicator of underground water. (The phrase "for full development" does not apply to the second statement and should be transposed after "considerable water.")

The individual grains in the coarser limestone are as much as a millimeter in diameter and average 0.02 millimeter in the finer-grained beds. (As thus written the subject of the verb "average" is "the individual grains in the coarser limestone." Write "The individual grains * * * diameter, and those in the finer-grained beds average 0.02 millimeter.")

Because of its generally dark color it is somewhat somber for building stone but makes a very substantial structure. (The dark color does not affect its durability. Put a comma after "building stone" and insert "it" after "but.")

In 1889 Charles Earle began a careful study of the material in the Princeton Museum and in 1892 published his memoir on the genus *Palaeosyops*. (Put a comma after "Museum" and insert "he" after "1892.")

During the summer a pool of water forms on the ice and gradually freezes again during the winter. (Change to read: "During the summer a pool of water forms on the ice; during the winter it gradually freezes.")

No lead and manganese were reported in these analyses and were evidently negligible. (It might be taken for granted that "no lead and manganese" would be negligible. Write "Lead and manganese were not reported", etc.)

Very little sulphide is present in the main ore shoot, but *it* [sulphide] is relatively abundant along the margins. (It is sulphide, not "very little sulphide", that is abundant.)

Undesirable change in construction

Many sentences that should preferably be written without change in construction are begun with a clause containing an active verb and ineptly broken by the unnecessary introduction of a new subject nominative that leads to the use of a passive verb at the end, with obvious loss of logical continuity and of clearness and force. The following sentences show this undesirable transition from active to passive verbs:

Water absorbed at the surface percolates downward until [it reaches] the zone of saturation *is reached.*

These vugs carry no gold and [do not affect] the tenor of the vein *has not been affected by them.*

The workings were closed and *examination of them* could not be *made* [examined].

The rocks show both bedding and cleavage, but *the amount of* [not much] metamorphism *has not gone far.*

The main vein here splits *and* [giving off] a spur vein *is given off.*

This series is made up largely of shale, *though* [but includes] much sandstone and limestone *are included.*

Occasionally a writer introduces this fault simply by failing to stop when he gets through, as in the following examples:

It contains coal plants and the remains of bivalve crustaceans *are found in it.*

In June the company took over the Primrose claim and in July the Bluebell claim *was acquired.*

The limestone contains considerable organic matter and chlorite *is extensively developed in it.*

The break in the continuity of some such miswritten sentences not only puts unemphatic words in the place of emphasis but detaches the final clause from the sentence, so that it hangs apart, without expressed relation to the matter to which it pertains, as in the following sentences:

The deposits are composed of fairly well stratified rocks but [contain many] large irregular boulders *are numerous.*

The district has been intensely glaciated and [includes] two distinct types of topography *exist.*

The rock in this locality is of rather low grade and very little *mining* [of it] has been *attempted* [mined].

The coal-bearing beds are not overlain by glacial gravel, *so deeper weathering has taken place* [and have therefore been more deeply weathered].

In many sentences the passive form does not afford the best means of expression. "It was expected to be found" is distinctly inferior to "I expected to find it." "It is believed by many geologists" is no better than the briefer statement "Many geologists believe." Phrases like "It is believed to be" and "It is supposed to be" are generally used only to express the writer's belief or supposition and serve merely to multiply words. The words italicized in the following sentences can easily be spared: "It is *believed to be* probably a stream deposit"; "It *is supposed that it* may be due to a fault." The reader will readily accept "may be", "probably", "perhaps", and like words as an expression of the writer's judgment of the probabilities.

Logical defects

Many sentences cannot stand the test of logical analysis, their writers having failed to keep in mind the relations of all parts of the sentence to one another.

An uninhabited country fully 50 miles square lies north of the San Juan, yet it is visited during winter by herdsmen. (The "yet" clause was probably intended to contrast with "uninhabited", but as the sentence is written it contrasts with the statement that the area "lies north of the San Juan"—a fact which would of itself have nothing to do with the herdsmen's visits.)

Unlike West Virginia, however, the losses in the organized districts of Pennsylvania offset gains in the nonunion field. ("Losses" are not comparable with West Virginia.)

The red berries induce violent illness in man, which is no hardship, since they are not at all palatable. (What he meant was that because the berries are sour it is no hardship to refrain from eating them; what he said was that the illness induced by eating them is no hardship.)

In May and June pumping rapidly increases again to a maximum in August. (The pumping couldn't reach "a maximum in August" in either May or June. The idea that the writer failed to express was that it increases in May and June and reaches a maximum in August.)

One of the most interesting place names in Manitoba is "Norway House", famous over a century ago as a district headquarters of the Hudson's Bay Co. (A place name cannot become a headquarters in the same sentence. Change "place names" to "places.")

The evidence of this one species is unimportant, nor is the deduction drawn from it by Mr. E. (The "nor" requires a preceding negative; change "unimportant" to "not important", or else change "nor" to "and so.")

Because o the character of its basin, its large and well-sustained flow, and its steep gradient, Rogue River is well suited to use as a source of power. (The first item—"character of its basin"—should be specific, like the others: every basin has a "character" of one sort or another.)

The chalcopyrite followed closely upon chloritization and replaced that mineral. (The only mineral mentioned is chalcopyrite; obviously it did not replace itself, and the chlorite that it did replace must be inferred from the "chloritization", which is not a mineral but a process. Change "that mineral" to "the chlorite.")

The original character of the rocks has been so largely destroyed as to be a serious hindrance to geologic mapping. (In some regions the "original character of the rocks" may be so complex as to make geologic mapping difficult, but the idea in the author's mind, which he failed to express in his sentence, was that the mapping is hindered by the destruction of the original character.)

The structure of the elongate ranges is so incompletely understood *as to hamper* [that] any attempt to study the origin of the valleys between them [is hampered].

The topography has been so much modified since the old glaciation as to obliterate most traces of morainal topography. (This sentence is also like the outmoded style of having twin vases at the two ends of the mantelpiece: it begins and ends with "topography." Change the last part to read "* * * glaciation that most traces of moraines have been obliterated.")

Defects in logic appear in many of the examples given elsewhere in these pages, under more specific headings.

Misplaced words and phrases

Adverbs and adverbial phrases are by some writers commonly misplaced, especially the adverb "only", which should be placed as near to the word it qualifies as the proper construction of the sentence will permit. In the sentence, "Their presence can only be determined by actual tests", the "only" should go after "determined." (Incidentally, it is not clear how "actual tests" would differ from "tests.") Other adverbs that are generally misplaced are "principally", "mainly", "chiefly", "alone", "also." An example is seen in the sentence "The sediments were principally derived from quartzite", in which the "principally" should follow "derived."

Phrases beginning with prepositions also become misplaced, as shown in the following examples:

Under such conditions it is easy to see that [under such conditions] the commercial development of these deposits * * *.

In 1917 it is probable that this region may be reached by railway [in 1917].

In Indiana recent writers have classified the rocks [in Indiana] as Utica or Eden.

On level 2 it is reported that considerable realgar and orpiment were found [on level 2].

The samples were preserved *for analysis* in a paraffine-sealed flask [for analysis].

The sentence "There is a band of coarsely crystalline limestone carrying bunches of garnet-pyrite rock from place to place" presents the ludicrous picture of an animated limestone carrying bunches of rock hither and yon. Better write "Here and there is a layer of coarsely crystalline limestone containing bunches of garnet-pyrite rock." "Layer" is a better word than "band", which refers simply to the visible edge of the layer.

The statement that "Care should be taken to see whether such wells are contaminated by frequent analysis" seems to be slander of the analyst. Write: "The water should be analyzed frequently to see whether such wells are contaminated."

Occasionally an adjective is misplaced or is misused for an adverb and misplaced, as in "A careful sample of this rock was taken for chemical analysis"; "The granite was intruded during the great period of structural deformation"; "leaves room for little doubt"; "the luxuriant gray-green of the sagebrush"; "tilted edges of sandstone strata"; "the *hasty* cover dug [hastily] by the infantryman"; "the most prevalent region of cloudbursts." In "a coarsely porphyritic rock of dark granular texture" it is the rock, not the texture, that is dark. "Two altered thin vitric tuff beds" should read "two thin beds of altered vitric tuff."

In general a phrase that applies equally to two or more items should be given with the first and not with the last—for example, "mountainous in the western part of the quadrangle and level in the eastern part." The reader should not be compelled to look ahead to get the full meaning of the "western part." So also "The thickness ranges from 700 feet at the east [side of the area] to perhaps 1,600 feet at the west side *of the area.*"

Parallel construction

Some writers seem to think that it is a fault to use the same construction for phrases that are parallel or coordinate in meaning. In their attempts to introduce variety they succeed only in introducing confusion. Long ago Lord Kames [23] wrote:

> Uniformity in the members of a thought demands equal uniformity in the verbal members which express that thought.

The following sentences illustrate the misleading combinations that result from failure to observe this requirement:

> The average growing season *according to the Ennis record* is 98 days [at Ennis] and longer at the other stations. (Not "98 days and longer.")
>
> The district has a moderate climate, in winter not very cold and *not excessively hot* in summer [not excessively hot].
>
> The veins pinch out in one direction and *in the other* pass under the glacier [in the other].
>
> The facets are best preserved near the base and *higher up* have suffered from erosion [higher up].
>
> These leaves vary in length from 6 to 9.5 centimeters and [in width] from 4 to 7.5 centimeters *in width.*

[23] Home, Henry, Elements of criticism, new ed., p. 308, 1855.

Snow fields may occur *in any latitude* at high altitudes [in any latitude] and at all altitudes in high latitudes.

The boundary between the belts is fairly distinct in places and in places indefinite. (Write "distinct in some places and indefinite in others.")

The biotite replaced albite and quartz very extensively and *sparingly replaced* hornblende [sparingly].

Some sentences of this sort cannot be corrected by simple transposition:

Most of the white arsenic is exported to America and *South Africa takes* most of the other products [to South Africa].

Limestone in massive layers and *thin beds of* shaly sandstone [in thin beds].

The following sentences, each containing two complete statements, could be somewhat improved by inserting the commas indicated in brackets, but a comma, even if its use is permissible, is generally an inadequate remedy for a miswritten sentence, and mispunctuation only adds to the faults.

The report represents a large amount of careful work [,] and a comparatively small amount of good work would improve it materially. (A better remedy would be to omit the comma and write "and would be materially improved by a comparatively small amount of good work." The reader may wonder, however, what was the distinction, if any, in the writer's mind between "careful work" and "good work.")

The waters of collieries in Durham and Northumberland carry barium [,] and barium sulphide has been found in pipes that lead from the coal pits. (Better "Barium occurs in the waters", etc.)

Other sins against parallel construction are illustrated in the following examples:

Estimating the potential value of power sites and storage capacities of reservoir sites. ("Capacities" should be changed to "capacity", an abstract term like "value.")

The replacement of pyrite by chalcocite would involve an increase in volume; the corresponding replacement of chalcocite would *occur with a slight volume decrease* [involve a slight decrease in volume]. (Change in form of a phrase may be taken by some readers to indicate a difference in idea, but in this example the only difference is that between "increase" and "slight decrease": the two phrases are parallel and should be expressed in the same form.)

The layers of shale are much thinner than the *chert* layers [of chert].

Misleading forms of expression

A writer should avoid the use of misleading phrases like "In the Cambrian limestones are found", which seems about to tell something about the Cambrian limestones but was written to mean that limestones occur among the Cambrian rocks. In the sentence "From the ice water overloaded with glacial debris discharged westward", the insertion of a comma after "ice" is an improper remedy for the unfortunate construction; the best remedy is to transpose the phrase "from the ice" to the end of the sentence and thus throw out the "ice water."

Continuity

The long sentence is unobjectionable if it is well knit together and runs smoothly on, with no pitfalls of bungling construction or obscure reasoning to test the reader's patience and skill. Long parenthetic clauses,

whether set apart by parentheses, dashes, or commas, are likely to cause the reader to lose the main thread of the sentence. If he must be halted by an aside the halt should be brief. On the other hand, a "choppy" style produced by a succession of short sentences is like the "rat-tat-tat" of a pneumatic riveter and should be avoided. A few years ago a scientific news service described the comma as "the greatest foe of those of us who attempt to write clearly for the public" and in connection with that assertion gave, presumably as an example of clear writing, a statement of about 250 words in which not a comma was used. A part of this statement is quoted below.

If we are to popularize our product we must bear in mind that the reading public is not patient.
The public with which we deal is a new public.
It is under a highly nervous tension.
It must do quickly the thing it has in mind.
It must be on its way.
It is a public that is subjected to rapidly succeeding periods.
Here are the periods of its daily grind.
It awakens. Sometimes it washes. It eats. It reads while it rides to office or factory. It works. It lunches. It works. It rides and reads. It eats. It plays. It sleeps.
It will read what is easy to read. It will not read what is hard to read.

"Hard to read" certainly describes such a style as that. It takes more nerve force to stop and start again every few words than to keep going for a reasonable time.

Above all things an author, even after he has observed the minor proprieties, should remember that logical order and easy continuity of thought are prime requisites of effective writing. Not only should his words and phrases be well chosen and arranged in sentences in an order that will lead the reader easily forward, but the sentences themselves should be properly grouped in paragraphs, and the paragraphs should be presented in logical sequence under suitable general headings.

Repetition of words

Undesirable repetition

An author's chief care in writing a sentence, as in writing his report as a whole, should relate to order—he must see that the clauses, phrases, and words are in their proper places—but he must also see that his words are used in unmistakable senses, that unnecessary words are not used, and that words of certain classes are not overused. The psychology of style has not been much studied, but some of its principles are obvious. A writer may repeat close together without offense any one of certain minor words; he may use again and again such words as "a", "the", "and", or "of"; but if he often repeats in a single sentence or paragraph a word like "data" or "occurs" or "important" and especially a more unusual word, the repetition at once diverts the reader's attention from the subject matter to the words. The editor of a small-town newspaper

once heard or read the word "blatant", which was altogether new to him, and he was so delighted with his discovery that he used it half a dozen times in his next issue. Once would have been enough, but six times simply advertised his own naïveté rather than the several examples of blatancy he was describing.

It is undesirable to use a word in two senses in the same sentence. A distinguished university professor wrote, in a Survey manuscript: "These do not resemble the diatomaceous remains found in the chalky shale, and their character remains indeterminate."

Proper repetition

A defect related to lack of clearness is the painful effort of some writers to use a substitute for a term that ought to be repeated to avoid switching the reader's train of thought off the track. "Tautology" is their bogey-man, but they have no clear idea of what tautology really is. A competent critic [24] writes:

> A notion is prevalent that the repetition of a leading word or words in a sentence or short period constitutes an offense called "tautology." In this false sense of tautology the mathematician might incur censure for the repetition of symbols in an equation. If the word first accepted be precisely the word wanted, to vary it is to vary the sense, to confuse the argument, and to vex the reader.

The term first used and farther along replaced by synonyms in the sentences below should be repeated as shown:

> This species is based upon a single incomplete specimen; a second *example* [specimen] showing similar sculpture * * *.
>
> On the west side of the mountain * * * but on the east side of the *same eminence* [mountain] * * *.
>
> Water supplies which in more humid regions are wholly or almost *entirely* [wholly] neglected here become of great importance.
>
> Most of the phenomena are due to lack of water rather than to the presence of *that agent* [water].
>
> This sandstone is well exposed at Whiskey Gap, where it forms the *most constricted* [narrowest] part of *this topographic feature* [the gap].

To understand the sentence "Andesine and augite are the essential minerals and usually are found in the proportion of 3 of the plagioclase to 1 of the pyroxene" the reader must remember that andesine is a plagioclase and augite is a pyroxene. The variation in terms was unnecessary, anyway, because "the proportion of 3 to 1" would have been perfectly clear. The writer in the next sentence used neither "andesine" nor "plagioclase" but "feldspar"—three terms for the same thing in three lines.

The phrase "the same" should not be used to represent a preceding noun, as in the following sentences:

> Neither a mere report on the area nor a monograph on the same.
>
> In appearance it resembles epidote *and is often mistaken for the same* [, for which it is often mistaken].

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[24] Allbutt, Clifford, op. cit., pp. 127–128.

The writer of the following sentence avoided what he thought would be tautology not by the use of a synonym but by too much condensation: "The formation is of fresh-water origin in the west and *brackish* [of brackish-water origin] in the east."

The sentence "Moose tracks have been observed by prospectors, and possibly *this animal* [moose] may occasionally stray into the district" illustrates a double impropriety; the phrase "this animal" in the second clause has no antecedent noun, for "moose" in the first clause is an adjective. A rather similar sentence follows: "The rocks are termed hornblendite, *from the predominance of that mineral* [because their predominant mineral is hornblende]."

Words and phrases misused

Stilted and showy writing

Some members of the Geological Survey, if their manuscript reports can be trusted, never go anywhere—they invariably "proceed": "From this point the writer proceeded to Oshkosh"; "the party then proceeded westward." Neither do they "begin" work; they "inaugurate" or "initiate" it. Nor do they "get" or "obtain" information; they "secure" it. If the area in which they are working is not large they would call it not "small" but "limited" or "restricted." If they work in cooperation with State geologists the work is not "done"; it is "conducted." Even some of the older Survey writers prefer the long and the wrong word, and many of the younger men forget their naturally simple and easy ways of speech when they sit down to write a Government report, the change in their mode of expression being similar to that wrought by love in a young man as described by Benedick in "Much ado about nothing":

> He was wont to speak plain and to the purpose, like an honest man and a soldier, but now he is turned orthographer; his words are a very fantastical banquet, just like so many strange dishes.

The writer who is thus under the spell of authorship will write of "superficial circulation", meaning surface water, or of "the vegetational aspect of the vicinity", or of "the ultimate nonanalyzed data of all happenings that may be apprehended"; or he may report that "the high-pressure area which collects over the Great Plains here accelerates the prevalence of westerly winds." He may even stumble by using the wrong high-sounding word, as in "mitigated against successful operation." He meant "militated against", but the plain word "hindered" would have served his purpose better.

One author wrote of water samples being "withdrawn through ordinary garden hose by a portable manual pump." It would seem that a prosaic garden hose might well have been linked with an equally prosaic "hand pump."

Occasionally an author recognizes this fault before it is pointed out to him by the critic: one writer changed "hydropneumatothermal contact action" in his manuscript to "hot solutions."

Some of the fantastic or pedantic phrases and ill-used words seen in manuscripts of Survey reports seem to be written to make a show of learning; others are evidently designed to be ornamental; but a young writer's attempt at literary ornament may be merely ludicrous. A teacher of English[25] writes:

> Showy language, like showy dress, is in bad taste. The essence of artistic language, as of everything artistic, is not abundant ornament but appropriateness. Straining for high-sounding expressions to replace plain English makes a style weak and crude.

The enthusiasm of some writers for their studies leads them to apply such terms as "splendid" and "beautiful" to fossils, exposures, specimens, etc., that have neither splendor nor beauty in the primary sense of the words. It is easy to find a more appropriate designation, such as "excellent", "remarkable", "well-exposed", or "well-preserved."

"Inaugurate" and "inauguration" may be reserved for use in Washington on January 20 and for other appropriate occasions; "initiate" is a good word to employ in connection with ceremonies in secret societies, for example, or, judiciously, in connection with some other things; and "secure" may properly be wedded to "security", if only to encourage the use of good English, particularly as the word is not needed in the sense of get, obtain, or procure. There is an old story of the young man who invited his extremely fat inamorata to attend the opera and on her asking "Have you secured the seats?" replied, "Oh, I didn't think that would be necessary."

Even the dictionaries are disposed to proscribe the use of "limited" and "restricted" for "scant" and "small":

> Limited is often faultily used for small, scant, slight, and other words of like meaning, as "He has a limited acquaintance with Milton"; "sold at the *limited* [low or reduced] price of one dollar."—Standard Dictionary, 1913 ed., p. 1437.

The better critics of English, from whom the dictionary makers occasionally take advice, have noticed the same fault. One of them[26] writes:

> Limited (from Mid. Eng. limiten—Fr. limiter, from Lat. limes, boundary) is often faultily employed for the plain English adjectives small, slight, scant. "His pecuniary circumstances were likely to be, for some years at least, very limited." This phrase, though not perhaps commendable, might be defended, the notion conveyed by it being the exact reverse of boundless or unlimited wealth. But in the two following passages limited is unquestionably wrong:
>
> "The cost of the volume was formerly five shillings; it is now published at the *limited* [low or reduced] price of one shilling."
>
> "If we may found an opinion on a *limited* [slight] acquaintance with the writings of Tieck." (An "unlimited acquaintance" would be strange.)

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[25] Woolley, E. C., Handbook of composition, p. 9, 1907.

[26] Hodgson, W. B., Errors in the use of English, p. 43, 1889.

The pathetic fallacy

What Ruskin calls the "pathetic fallacy"—the ascription of human qualities to inanimate objects—though picturesque and appropriate enough in such works as the plays of Shakespeare ("Pity, you ancient stones, those tender babes whom envy hath immured within your walls"), seems a little far-fetched in a scientific paper. The author who wrote "Similar forms in humid climates suffer basal steepening and may therefore enjoy accelerated back-weathering" used this figure twice, though perhaps the amusing contrast between "suffer" and "enjoy" was inadvertent.

Standpoint, point of view, and basis

Such phrases as "from the standpoint of" and "on the basis of" are overused by some writers, who employ them in connections where their propriety may be questioned, as "from the standpoint of coal mining", "from the viewpoint of road building", where "coal mining" and "road building" are used for "the coal miner" and "the road builder." "From the point of view of farming" means "from the farmer's point of view"; the farmer, but not farming, may occupy a point of view. "Viewed from the standpoint of age these rocks are Miocene" is a bad equivalent of "These rocks are of Miocene age" or simply "These rocks are Miocene." "The value of the land from an agricultural standpoint" means simply "The value of the land for agriculture" or "The agricultural value of the land." In the sentence "The conclusions stated appear to be warranted on the basis of the data presented" the word "by" may be used in preference to "on the basis of." The italicized words below may with advantage be replaced by the words in brackets:

The rocks on the basis of [If classified by] size of grain [the rocks] may be divided into sandstones and conglomerates.

The external factors, such as railroad transportation and markets, may determine absolutely *from the commercial standpoint* the [commercial] workability of the coal.

A small area in Texas was examined *from the oil and gas structure standpoint* [to determine whether the structure was favorable to the occurrence of oil or gas].

A rock-cut trail, picturesque in the extreme *from the standpoint of* [in its] ruggedness and [in the] precipitous gorges and rocky slopes [it discloses].

From a genetic point of view [The genesis of] the coralline limestones *have* [has] been more carefully studied.

This is too important a matter to be treated *from a careless point of view* [carelessly].

From the standpoint of [According to] this theory.

The ridge is [topographically] symmetrical *from a topographic standpoint.*

It may be questioned which part of the circulating water is the more effective *from the standpoint of* [for] solution and transportation.

Let us now consider the [chemical composition of the] important rock-making minerals *from the general standpoint of their chemical composition.*

A flora which is of great interest *from a comparative paleobotanical standpoint* [to the student of comparative paleobotany].

[Considered geologically] The range may be divided into two parts *from a geological standpoint.*

If any such minor folds are present they are important *from the oil and gas standpoint* [in relation to the occurrence of oil and gas].

Based on [From] measurements made on photographs Brown estimates * * *.

"An attempt to frame a working hypothesis on an atmospheric basis" leaves the reader somewhat "in the air" as to the meaning intended.

Along these lines

"Along these lines" or "along this line" is condemned by the rhetoricians as "trite"; it is generally worse than that: it is not precise or at once clear and it usurps the place of better phrases. The following sentences can easily be improved:

A large part of the area is irrigable, but *activities along this line have up to the present time been* [the irrigation now practiced is] confined mainly to the stream valleys.

Investigations along petrographic lines (=petrographic investigations).

These analyses were *conducted along the same lines* [made in the same way].

In speaking of a certain mineral a geologist writes "Its application along all these lines is expanding", meaning "Its use for all these purposes is increasing."

Other misused phrases

The phrase "is responsible for" is improperly used where no responsibility is involved, as in the following sentences:

The uplift of the Ben Lomond block *is responsible for* [produced] this escarpment.

A flood in the eighties *was responsible for* [caused] this damage.

These valleys will be referred to under the heading "Geologic history", where the glacial erosion *responsible for* [to which] their characteristic forms [are due] is *narrated* [described].

The rock is *earlier in age* [older] than the *period of* regional metamorphism that *was responsible for* [resulted in] the present structure of the enclosing schist.

"In the vicinity of" or "in the neighborhood of" are unnecessarily used for "about" or "nearly", as in the following sentences: "The cost of production is in the vicinity of 50 percent of the selling price"; "Its population is in the neighborhood of 1,500."

The phrase "in question" is used by some writers concerning matters that are not at all in question, as "The lake in question", for "The lake mentioned" or simply "This lake."

Former and latter

"Former" and "latter" are often misused. They should not be employed in a sentence that is so long and involved that the reader will have to look back to find what the words mean. A good general rule is to repeat the words to which they refer. Of course "former" and "latter" cannot be used if there are more than two antecedents, as in the sentence "The granite consists of quartz, orthoclase, and biotite, the former constituting two-thirds of the rock." By some writers these words are used without reason, as in the following sentences:

The quartz veins lie near bodies of muscovite-biotite granite, *the latter being* [which is] probably the latest rock in the region.

These ores are associated with iron oxide, *the latter having been* [which has been] deposited nearer than the zinc to the lead ore.

The mines and the smelter were operated until the first of November, the *latter* [smelter] treating an average of 360 tons daily.

Most such deposits contain calcite, and where they carry copper-iron sulphides the latter will oxidize to carbonates, silicates, and oxides. (Write "Most such deposits contain calcite, and any copper-iron sulphides they carry will oxidize", etc.)

These words are used by some writers in a way that absolutely conceals the meaning intended, which must be guessed or inferred from the context. Examples are given below.

The concentration of the sulphide ion is so greatly affected by change of acidity that *the latter* [this change?] is the principal factor determining the precipitation of sulphides.

One of the purposes of the reconnaissance was to examine certain prospects containing ores of uranium and vanadium, and it is to *the latter* [these ores] that this report is confined. (The context shows that the phrase "the latter" means the ores of both uranium and vanadium.)

The house and chimney swing with different periods under the impulse imparted by the ground, and the *latter* [chimney] is broken off, usually at the roof line.

Other misuses of "latter" are indicated below.

I have seen all the phenomena herein described but have minutely studied only small portions of them. It would be impossible for any one man to do the latter unless he made it a life task. (Search for an antecedent for this "latter" would be fruitless. What the writer probably meant but did not express by "to do the latter" was "to study them all minutely.")

Movement continued along these faults during and after these intrusions, causing the latter to be shattered. (The grammatical antecedent of "latter" is "intrusions", but a process cannot be shattered, and "latter" should be changed to "intrusive rocks", which also gets rid of the rhyme in "latter" and "shattered." Another offense against euphony as well as against clearness is shown in "fragments of float from the latter may litter the hillside." Gilbert and Sullivan alliteration has no place in a geologic report.)

This *latter* outcrop approximately parallels the Red Mountain outcrop at a distance of about 3½ miles *from the latter*. (The antecedent of the second "latter" is not the same as that of the first, and both can with advantage be omitted.)

In the following sentence there are no proper antecedents for "latter and "former"; they appear to refer to terms of color instead of to the minerals of the colors named:

In color the chrysocolla ranges from reddish brown to brownish black; rarely it is light blue. The *latter* [blue chrysocolla] has a vitreous luster and is crystallized, but the *former is* [brown varieties are] dull and in most places amorphous or crystalline.

Occasionally an author may employ one of the terms of this misused pair and give the true word for the other:

When petroleum is forced through a bed of shale it is fractionated into its lighter and its heavier components, the *former* [lighter] passing through the shale and the heavier *parts* remaining.

The geologic processes involved the intense fracturing of parts of the mass and the subsequent introduction of pyrite and chalcopyrite, the *latter* [chalcopyrite] very finely disseminated and intergrown with the pyrite.

After reading these sentences, all quoted literally from Survey manuscripts, the reader may see why many critical writers decline to use "the latter" and "the former", even where their avoidance is troublesome.

Leslie Stephen [27] writes of the "special difficulty of making the 'he's' and 'she's' refer to the proper persons without the help of the detestable 'latter' and 'former.'" An eminent English historian [28] writes:

I learned from Macaulay never to be afraid of using the same word or name over and over again if by that means anything could be added to clearness or force. Macaulay never goes on, like some writers, talking about "the former" and "the latter", "he", "she", "it", "they", through clause after clause, while his reader has to look back to see which of several persons it is that is so darkly referred to.

The "dean of American letters" [29] writes:

Why any human being should write "the former" and "the latter" when all are at liberty to repeat with distinction the nouns that these pronominal stuffed images stand for we never could comprehend.

Cases and instances

Such "cotton-wool" words as "cases" and "instances" have been condemned by many critics. Fowler [30] says:

Case. There is perhaps no single word so freely resorted to as a trouble saver and consequently responsible for so much flabby writing.

Instance. * * * There is some danger that, as writers become aware of the suspicions to which they lay themselves open by perpetually using "case", they may take refuge with "instance", not realizing that most instances in which "case" would have damned them are also cases in which "instance" will damn them. The crossing out of one and putting in of the other will not avail: they must rend their heart and not their garments and learn to write directly instead of in periphrasis.

Quiller-Couch [31] devotes a whole chapter to "jargon", in which he describes "case" as "jargon's dearest child" and rails at the vice of using "circumlocution rather than short straight speech" and habitually choosing "vague, woolly, abstract nouns rather than concrete ones."

Another critic [32] says, " 'Case' and 'instance' are the commonest and most dangerous of a number of parasitic growths which are the dry rot of syntax."

Examples of the improper or superfluous use of these words follow:

The lowlands in some *cases* [places] contain lakes, the most conspicuous *instances* being Crystal, Glen, and Portage Lakes.

In a few *instances* [places], as at Clement Point * * *.

One such case is definitely known to have formed a cinder and ash cone over 200 feet high. (So elusive a thing as a case cannot form so substantial a thing as a cinder cone.)

The author who writes that "Specimens in some cases show veins of calcite" does not intend to refer to specimens in cases; he means simply "Some specimens," which should be denoted clearly by two words instead of doubtfully by four.

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[27] Studies of a biographer, vol. 1, p. 23, 1898.

[28] Freeman, E. A., Internat. Rev., September 1876, p. 690.

[29] Howells, W. D., Harpers Mag., March 1914.

[30] Fowler, H. W., A dictionary of modern English usage, pp. 65, 277, 1930.

[31] Quiller-Couch, Arthur, On the art of writing, pp. 100–126, 1916.

[32] Chapman, R. W., The portrait of a scholar and other essays.

The following phrases and sentences contain objectionable "cases" and "instances":

The appearance of [such specimens of] the ore *in such cases* as were examined.

The enrichment observed in the *case of the* copper veins.

In most of these *cases it has been found that the* coal beds have certain peculiarities by which they may be recognized.

In the case of the solutions affecting the monzonite *they* were evidently rich in potash.

In most cases metamorphism is [usually] accompanied by chemical changes.

The classification was not sufficient *in all cases* to determine the status of [all] the lands.

In many *cases* [of] these well records have been carelessly kept.

This is the only *instance* [magnetite mine] in the quadrangle *of a magnetite mine* that is wholly in the limestone.

In one *case* [specimen] of a fresh rock small prisms of augite are fairly abundant, but *in the majority of cases* [generally] the ferromagnesian silicates are represented only by chlorite.

In every *case an* alteration product should be identified with extreme care. *In* each *instance the* supposed *fact* [identification] should be scrupulously verified.

If later sediments were deposited upon the Perry formation *as was the case* [in this region, as they were] in parts of New Brunswick, [they have been removed by] erosion *has removed all of them.*

There are several cases, however, where wells * * * finally fail to yield either oil or water. In such cases the casing has been pulled and the hole filled with cement (Write "Several wells, however, finally fail * * *. In such wells the casing", etc.)

Occasionally an author uses the proper concrete term and farther along in the sentence employs "cases" or "instances" as a synonym, thus at once introducing two faults. (See p. 63.) An example follows:

In some places the conglomerate is composed entirely of fragments of [gray or greenish-gray] shale, *and in such instances it is gray or greenish gray.*

The first of the two columns below shows sentences containing undesirable or superfluous "cases" or "instances"; the second column gives interpretations in plainer English.

In the great majority of cases where coal exists but has not been found to be workable it lacks one of three things—either quality, thickness, or accessibility.	Most unworkable coals are deficient in quality, thickness, or accessibility.
In the case of malacone the formula proposed is not absolutely certain.	The formula proposed for malacone is not absolutely certain.
As in the case of oil lands, phosphate lands are withdrawn * * *	Phosphate lands, like oil lands, are withdrawn * * *
In the case of Indian lands that are to be thrown open to settlement it is desirable to know beforehand what parts of the lands contain valuable mineral deposits.	Before Indian lands are thrown open to settlement it is desirable to know what parts of them contain valuable mineral deposits.
One of the most interesting cases illustrated an instance of what appeared to be a puzzling case of vertical bedding.	One of the most interesting features of the deposit was what appeared to be a puzzling example of vertical bedding.

The habitual use of abstract terms like "cases" and "instances" for concrete, clearly significant terms that can be easily understood constitutes one of the worst vices of technical writing—it is one of the characteristics of "technese", that ill-written lingo that usurps the place

of plain English. It not only multiplies words but befogs meanings, imposing unnecessary burdens on the reader. This vicious habit can be cured if taken in its early stages. The victim should ask himself, after he has written "cases" or "instances" or some other abstract term, "What do I mean by this word? What is the concrete thing about which I am writing?" He can generally find it without trouble, or he will discover that his "cases" and "instances" are mere excess verbiage. The fuzzy habit of thought that leads a writer to use these words may also be reflected elsewhere in his writing, as illustrated in the following example, which, happily, is not taken from a Survey manuscript but from another Government report:

It is seldom the case that one department or bureau is enabled to render a service with such potential possibilities of the results being of value to so many departments or bureaus as it is believed is the case in this instance.

The unnecessary and undesirable use of other abstract terms is illustrated in the phrase "good examples, some of them 5 feet in diameter", in which "good examples" means "typical boulders." The following sentence affords another illustration of this habit: "The degree of induration here is very great, and the rock fractures across the grains like a dense quartzite", meaning "The rock here is very hard and when fractured breaks across the grains like a dense quartzite."

Character, conditions, purposes

"Character", "conditions", "purposes", and like words are by some writers habitually intruded without reason into sentences in which they are superfluous or ridiculous, or both. The italicized words in the sentences below may easily be spared or may be replaced by the words in brackets.

The surface is *of a* very uneven *character*.
With proper drainage *conditions* the land could be made suitable for farming *purposes*.
The flow of the stream was obstructed by ice *conditions*.
Most of this petroleum is used for fuel *purposes*.
Under [In] baseleveled *conditions* [regions] underground circulation is sluggish.
The river here *loses its split-up character and* [is not split up but] flows in a single channel.
Cypress trees growing in marshy *conditions* [lands].
The *soft nature* [softness] of the beds.
The arkosic character of the beds appears to be prevalent in both regions. (Write "In both regions the beds appear to be arkosic.")
The mesas are arid, and *because of their disconnected character there is* [as they are disconnected they afford] no means of storing water for irrigation *purposes*.

"Some work of an exploratory character" means "some exploratory work"; "under extremely shallow water conditions" means "in very shallow water"; "tuffs of an andesitic character" probably means "andesitic tuffs"; "public roads of fairly good character" means "fairly good public roads"; and "stone suitable for building purposes" is simply "building stone."

Some other sentences in which these words are used undesirably are given below:

The specimen of limestone collected is of a rather friable character.

At later periods under less deep-seated conditions.

The very thin character of the coal beds.

The flat or gently rolling condition of the surface here gives way to an area of rugged topography.

This steel is used for car-wheel purposes.

The emerged condition of the region gave way to submergence.

The cessation of operations in the smelter had little influence on the abandoned condition of the camp.

These events reduced the area to a very low-lying condition.

A number

The phrase "a number of" is overworked by many writers. Probably it is usually intended to mean an indefinite rather small number, in about the same sense as what is generally understood by "several", but as 5,000,000 or 50,000,000 is also "a number" it seems preferable to use an appropriate and more specific substitute, such as "several" or "a few."

Doubled-up have, be, and been

Mark Twain, in his book "A tramp abroad", says:

Harris said that if the best writer in the world once got the slovenly habit of "doubling up his have's" he could never get rid of it—that is to say, if a man gets the habit of saying "I should have liked to have known more about it" instead of saying "I should have liked to know more about it", his disease is incurable.

The "doubled-up have" is occasionally seen in the manuscripts of the Survey's writers, and "have", "has", and other auxiliary verbs are by some writers doubled badly, as in the following sentences:

Faulting subsequent to intrusion *has been shown to have been* [was] subordinate.

These gravels *have the appearance of having* [look as if they had] been deposited by moving water and *have a strong resemblance to* [strongly resemble] the Gila conglomerate.

The known geologic history of the region *may be said to have been begun* [begins] in Silurian time.

It is expected that by March the [first] concrete will be *begun to be* put in place.

On the other hand, "to be" is often omitted where it should be used, as in "Cap Glacier is reported [to be] a thin névé field"; "The submarine topography appears [to be] chiefly the result of glacial erosion."

"Have" and "has" are used undesirably in the following sentences:

The deep erosion gives evidence that the rocks *have a* [are of] considerable age.

The alluvial soil *has* [contains] much sand and gravel.

The rocks *have a flesh color* [are flesh-colored].

The sample had *had no exposure* [not been exposed] to the air.

This form has the width 2½ times less than the length (incidental mathematical problem for the reader).

"Have" and "has" should be used as principal verbs with discrimination. "Has" would be a better word than "contains" in the sentence "This water contains a higher mineral content."

In the matter quoted below almost everything mentioned has something or seems to have something:

The rocks have a typical schistose structure. The planes of schistosity have a dip that seldom departs greatly from the vertical. The schistosity has a trend that is generally northwestward. The rock has a dark-gray color, and its surfaces have a satinlike luster.

Only one "have" is needed in the corrected matter, and perhaps even that one can be spared:

The rock is typically schistose, and the planes of schistosity generally stand almost vertical and trend northwestward. It is dark gray and its surfaces have [show?] a satiny luster.

The author's choppy and badly written matter contains 43 words; the edited form contains only 28 words and expresses the same ideas better, without choppiness, and it therefore shows a decided gain in economy and efficiency of expression, as well as an improvement in literary form.

While

"While" is too much employed by many writers, who use it as a conjunction instead of "though", "whereas", "but", or "and", as well as in its primary time sense, as an adverb.

Allbutt [33] writes:

I note that many of my candidates [for the degree of M. B. or M. D.] are content with one conjunction—"while", which is used indiscriminately for "and", "since", "although", "whereas", "notwithstanding", "nevertheless", "yet."

The same lack of discrimination is shown by some writers in the Geological Survey. These writers learned in their schoolboy days that "though" and "yet" are proper correlative conjunctions, but in Survey manuscripts they correlate "while" and "yet": "While this is the usual arrangement, yet * * *"; "While coal and oil command high prices, yet * * *." The "while" in the last sentence is also misleading, for at first it seems to be an adverb of time.

An author writes, "While this work is in progress it is not completed"—that is, "Before this work is done it is not done." Some recent explorations in Alaska are reported in this fashion: "Martin and Stanton devoted about two weeks to the general geologic problems while Stone spent about a month in studying the coal measures." Time thus seems to have passed more rapidly with Stone than with Martin and Stanton; or a month's work in the coal measures may equal only two weeks' work elsewhere; or perhaps Stanton's two weeks and Martin's two weeks should be added to equal Stone's month. Similar ludicrous comparisons are afforded by the following examples:

In Texas the men on strike remained out an average of over 20 days, while in Maryland they were out 155 days. (The days must have been long in Texas.)

[33] Allbutt, Clifford, op. cit., p. 98.

The mining on claim 3 is being done in winter, while that on claim 4 is being done in summer. (Contemporaneity of the seasons.)

The greatest geosynclinal accumulations in the Paleozoic were just east of the batholith, while comparable thicknesses of Mesozoic beds were deposited in a trough 150 miles or so farther east. (Telescoping of geologic time.)

In the following sentence "while" should be replaced in both clauses:

While [Although] windmills are economical, they are subject to destruction by severe storms, *while* [and] calm reduces the production to zero.

"While" in the following sentences should be replaced by "and":

In several of the Cretaceous formations they are among the most valuable diagnostic fossils, *while* [and] at a few localities they occur in great numbers.

Much uncertainty has existed as to the specific and generic relations of these forms, *while* [and as to] their geologic distribution *has been much in doubt.*

"While" should be replaced by a semicolon in the following sentences:

At some places this zone is 4 feet wide [;] *while* at others it narrows to 10 inches.

Quartz and calcite were locally deposited with the copper [;] *while* the zeolites were later than the copper.

"While" has been so much misused for "though" and other words that one author who had written "while" where he really meant it felt compelled on revising his manuscript to change it to "during a time in which." In the sentence "While the sea was shallow some sand was deposited" the "while" is used properly as an adverb of time, but as the word is so generally misused the author's meaning may not have been clear to some readers.

With

"With" is much misused, especially for "and." Examples of its misuse for "and" are seen in the sentences quoted below:

The vein has a northeast strike *with* [and] a vertical dip.

The Permian series consists of shale, sandstone, *and* limestone, *with* [and] a few thin beds of coal.

The rocks have been indurated [,] *and* tilted, *with some slight folding* [and slightly folded].

A small fissure striking north *with a dip of* [and dipping] 50° E.

The ores in the limestone consist of crystalline aggregates of magnetite *with* [and] small amounts of other *associated components* [minerals].

At San Marcial the average rainfall is 4.84 inches *with a* [and the] minimum *of* [is] 1.17 inches.

"With" is used in the sense of "but" and a verb in the following sentences:

The rocks are mostly gray slate *with* [but include] some graywacke.

The water is very clear *with* [but has] a faint bluish tinge.

The surface of the bedrock is fairly even, *with* [but contains] depressions representing temporary channels of the shifting creek.

"With" is sometimes used in place of a verb, as in the sentence "The rock is even-grained, finely laminated, and well bedded and *with* [exhibits] clearly defined horizontal jointing."

"With" is superfluous in the following sentences:

The term mica *includes* [indicates?] a group of minerals having similar physical properties and *with* related chemical composition.

The formation is made up of light-green, maroon, or purplish chalky-looking clay and marl, *with* a small amount of gray friable sandstone, and thin beds of gray or drab limestone.

The patient reader may interpret the following sentences "according to his lights":

A fine-grained rock which is greenish with blotches of a bright pink color.

The conglomerate pebbles are well rounded with a very loose cement.

The top of the mountain is flat with a smooth descent on the south and west.

He discusses the geology of the county with descriptions of nineteen mining districts.

New Orleans, a miserable little wooden town with 30,000 people and with 30,000 more in the rest of what is now the State of Louisiana.

The sentence "The adjacent lands and tributary streams are grass covered with scattered oaks" contains problems of vegetation and habitat that may baffle even the patient reader.

"With" and "by" should be discriminated in phrases like "was covered by ice", "is covered with ice." The grammarians and lexicographers say that "by" may indicate the cause or agent and "with" the means or instrument, a generalization that may be helpful but that does not invariably suggest a proper choice between these two prepositions. Write "This bed is overlain by", not "overlain with."

"Merges with" appears in some Survey manuscripts instead of "merges into" or "merges in." "The foothills here merge *with* [into] the plains."

"Differ with" is sanctioned to express difference of opinion, as in "I differ with him", but "differ from" should be used to express other differences.

Quite

"Quite" is by some writers used for "very", "somewhat", or "rather" or is used superfluously. Phrases like "quite large", "quite a distance", "quite a few" should be avoided. It is suggested that "quite" be used (if used at all) in its primary sense, to mean "entirely" or "completely", as in the phrases "quite conclusive" and "not quite finished." If used generally in this sense its significance in a phrase like "white, plastic clay quite free from sand" would be unmistakable, whereas, owing to the uncertain value of the word as employed by many writers, the exact meaning intended by the phrase quoted is doubtful.

Developed, development

"Develop" and "development" are used by Survey writers in too many senses. "Developed" is used to mean occurred, formed, exploited, worked, mined, or anything else that may happen to be in the mind of a writer who will not take the trouble to think of the word he really needs. A few of the diverse misuses of "developed" and "development" are shown below.

These were *developed* [formed] in greater thickness farther west.

The only deposit that has been *developed* [worked, exploited].

In this district ore bodies of considerable *importance* [value?] have been *developed* [formed?, worked?].

Here the vein is *developed in greater thickness* [is thicker].

The *large development* [great thickness] of Triassic sediments in this region.

It is possible that its development was in Tertiary time (="It was perhaps formed in Tertiary time").

This differs from the underlying formation in the absence of andesite and in the *development* [presence] of thicker masses of slate.

The *development* [exploitation] of the deposit will soon be undertaken.

Barren gossans *developed at a depth yielded* [were found to be underlain by] good deposits.

There is much lateral variation in the *development* [thickness?, character?, composition?] of even the most persistent strata.

At the crest of the hill the conglomerates are *typically developed* [exposed in typical form?, exposed in typical character and thickness?].

These salt pseudomorphs were observed on the south slope of the mountains, where they are *more prominently developed* [more numerous?, more conspicuous?, more nearly perfect?] than elsewhere.

The body of shale above the Dakota sandstone was named the Mancos shale on account of its characteristic *development* [exposures] in the Mancos Valley (="was named the Mancos shale, from Mancos Valley, where it is typically exposed").

In its typical *development* [phase?] the formation is a series of dark clay shales.

Neither the limestone nor the sandstone layer is *developed with sufficient uniformity* [sufficiently uniform?] to be traced for considerable distances.

In some *cases* [places?] the quartz *is developed* [occurs?, appears?] in anhedral grains.

Building stones are *better developed* [more common?, occur in greater quantity?] in adjacent quadrangles, and it seems probable that those of this area will not be much *developed* [exploited?, quarried?].

Here the plants of the century family attain their *greatest development* [largest size?, densest growth and largest size?].

These plants are here *present in less abundance and in more stunted development* [less abundant and smaller?].

Proven

"Proved", not "proven", is the preferred form of the past tense and the past participle of the verb "prove."

Proven=proved. Archaic and dialectical.—Webster's New International Dictionary, 2d ed., 1934.

Proven=proved; an improper form, lately growing in frequency by imitation of the Scotch use in "not proven."—Century Dictionary.

Proven [archaic]=proved; an irregular form, confined chiefly to law courts and documents. Proved is the true English preterit and past participle of prove.—Standard Dictionary, edition of 1913.

The judgments cited above apply to the past tense and past participle. As an adjective "proven" (from the Scotch) has been used by many reputable writers, but the variant form seems unnecessary.

"They never abandon a proven falsehood."—W. S. Landor, Imaginary conversations, 1829.

"He had got his proven sword into his hand."—William Morris, An earthly paradise, 1870.

"Ask'd me to tilt with him, the proven knight."—Tennyson, 1872.

"We must accept it as a proven fact."—Sir Clifford Allbutt, A system of medicine, 1897.

Value

A critic of technical writing [34] says, concerning the word "value":

> The misuse of this word and its plural is a good example of a colloquialism, harmless enough in a stope or in a mill but a solecism in literature. It is also an instance of the employment of the abstract for the concrete, one of the primary blunders in poor writing. "This mill is intended to extract the values in the ore" is a vague way of saying that it is meant to extract the gold or lead or silver or the valuable metals in the ore. Value is the desirability or worth of a thing; it is an attribute, not a substance. A man that designs a concentrator to "catch the values" might as well build a railroad to pursue a quadratic equation. Nevertheless, this vulgarism of the mining camp has crept into technical literature, and it can be found in articles otherwise well edited. Here are some examples:
>
> "In sinking the values were lost." Meaning that the ore became poor, or that the valuable ore ended.
>
> "The vanner saved all the values in the ore." Meaning the valuable minerals that the ore contained, or all that was valuable in it.
>
> "And then the gold values are precipitated on zinc shavings." No, it is the metallic gold that is precipitated; you can precipitate a panic by reckless banking, but you don't precipitate anything so vague as values on something so tangible as zinc shavings.

In some papers "values" is undesirably used for figures representing quantities, as in the sentence "For part of a month multiply the values for one day by the number of days", "values" meaning "run-off", or "figures showing run-off."

Range

"The coal ranges in thickness from 0 to 6 feet" and similar statements appear in some manuscripts. A reader who is told that two coal beds are "separated by 0 to 6 inches of bone" may wonder how great a separation would be made by 0 inch of bone. The sentence "The coal ranges from a thin film to a bed 6 feet thick" gives something tangible at each limit of the range. "Knife edge" and "vanishing point" are other acceptable terms to express the idea intended by the cipher in these phrases, as "This bed ranges in thickness from 25 feet to a knife edge [or to the vanishing point]."

Note also that the phrase "in thickness" and not the adjective "thick" must be used in the predicate after "ranges": "The bed ranges from 40 to 50 feet in thickness." "The bed is 40 to 50 feet thick" is correct, however.

If the range is not known and only the upper limit is to be given, the form "up to", which logically requires a preceding "from", should not be used:

> Microcline phenocrysts *ranging up to* [as much as] 2 inches long.
>
> The pebbles *range in size up to* [reach a maximum of] 6 inches in diameter. ("In size" and "in diameter" are not both needed, and "in diameter" is the more specific.)

The statement "The pebbles are up to 3 inches in size" gives only the maximum size, not the range; it is equivalent to saying that the largest pebbles are 3 inches in diameter, or that the pebbles are "as much as 3 inches in diameter."

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[34] Rickard, T. A., A guide to technical writing, p. 47, 1908.

If "range" is used, however, care should be taken to express the two ends of the range in coordinate terms—not as in the following examples:

The concretions range from *fine grains* [less than an eighth of an inch?] to 2 inches in diameter.

It ranges in width from a *narrow belt* [few feet?] to 60 rods.

This deposit ranges from a thin veneer to [a bed] several hundred feet [thick].

The sentence "These pebbles range in size from peas to walnuts" expresses the ends of the range in coordinate terms but is objectionable because "peas" and "walnuts" are not terms of size and are too indefinite anyway: peas and walnuts vary in size. What the writer probably meant was a range from the size of an average ripe garden pea to that of a walnut [black or English?] in its shell, but his idea would have been more clearly expressed by giving the range in some unit of measurement, such as the inch or centimeter. If he didn't want to be too specific he could have qualified the measurements by "about."

In a statement of range in size or price only two limits should be given. "The price ranges from $11 to $17 and $18 a ton" should be corrected to read "from $11 to $18 a ton."

The following sentence, which is only one of many like sentences found in Survey manuscripts, conveys no very exact information: "Its thickness ranges from 35 feet or less to 175 feet or more."

"Range" is a better word to express gradation than "vary", which may well be reserved to indicate variations or fluctuations like those meant by the sentences "The flow of the well varies"; "The stream varies in width"; "The tide here varies greatly in height."

Such

"Such" is misused by many writers. "This is not such a large deposit" should have been written "This is not so large a deposit", or "This deposit is not so large."

Note also: "The water occurs in alluvial sand *of such fineness* [so fine] that ordinary screens are of no use", "These boulders *are of such size* [so large]"; "The time expended in the field work was *such* [so short]"; "The deposit is *of such hardness* [so hard]."

This and these

"This" and "these" should not be used alone as subject nominatives where there can be any doubt as to their meaning, where the reader will be compelled to look back to find their antecedents, or where no antecedents have been expressed. The missing noun can generally be supplied, with advantage to the reader.

The rocks contain * * * numerous drusy cavities. In these [cavities] minerals of later age have been deposited. (Not "these minerals.")

In the Milesburg Gap the quartzite has been quarried to a considerable extent for ganister, and near *this* [the] quarry barite is found in narrow fissures. (No quarry had been mentioned.)

Horizon

"Horizon" is improperly used for "bed" or "stratum", as in the sentence "This horizon is 4 feet thick." The report of the committee on stratigraphic nomenclature representing the Geological Society of America, the American Association of Petroleum Geologists, the Association of American State Geologists, and the United States Geological Survey contains the following statement: [35]

> The term "horizon" * * * denotes merely position. A horizon has no thickness, being merely a stratigraphic level, or plane.

Instead of "This horizon is oil-bearing in all parts of the field" a writer would better say "Oil is found at this horizon in all parts of the field." In the following sentences "horizon" is used improperly:

> Several thin horizons are resistant and stand out prominently.
> The total thickness of the horizon that carries the conglomerate is 20 feet.

Structure

The awkwardness that is likely to result from the use of the term "structure" not only in the general, abstract sense, in which it denotes attitude, but in a concrete sense as applied to an anticline, syncline, or other structural feature is well illustrated by the following quotation:

> The principal * * * structure in the township is the * * * syncline, described on page —. It is probably to be regarded as a synclinorium, rather than a simple syncline, so that its structure is somewhat more complex than was formerly supposed.

The "its" in the second sentence refers to "structure" in the first sentence; "its structure" therefore means "the structure's structure." To avoid such awkwardness the term should be confined to its abstract meaning, and for the other sense some definite term, such as "anticline", "syncline", "dome", "terrace", "monocline", "fold", should be substituted, or, if an inclusive term is needed, "structural feature." (See Bulletin 661, pp. 78–79.)

Production

The lingo of many oil men includes such expressions as "the well failed to reach production" (meaning a productive stratum) or "the area beyond production" (meaning the productive wells). Such short cuts simply befog meanings and dull the edges of distinctions in expression.

Important

"Important" and "importance" are by some writers greatly overused. As a rule "important" is not the most appropriate word unless it is accompanied by some term denoting why or how the thing described is important, as "commercially important." It should not be used for

[35] Ashley, G. H., and others, Classification and nomenclature of rock units: Geol. Soc. America Bull., vol. 44, p 429, 1933.

"abundant", "conspicuous", "valuable", or any other word of clearly defined meaning. One of the early members of the Geological Survey,[36] who was also one of its best writers, said:

> Not unfrequently an essay ostensibly and mainly scientific will contain the statement that an object, or relation, or other phenomenon is "interesting", the context indicating that interest is supposed to inhere in the phenomenon. As a matter of fact, interest is a mental attitude of the observer, and the adjective "interesting", though applied to the phenomenon, describes only the observer's relation to it. * * *.
>
> Something similar may be said of "important", "valuable", etc., when employed in scientific description. In common with "novel", "pertinent", "significant", and the like, they indicate the relations of a phenomenon to the condition of human knowledge. Just as each observed fact has at some time, temporarily, the quality of novelty, so each fact and inference may in some phase of the process of knowledge serve to explain the previously unexplained and thus have importance or comparative value. Apart from such temporary and humanistic relations, all facts are equally important or equally unimportant. When, therefore, an author makes the bald statement that a fact is "important" he * * * is self-deceived if he thinks of the importance as an essential characteristic.
>
> It conduces to clear thinking as well as clear writing if one fortifies the use of "interesting" or "important" by pointing out the relation which endows the indicated fact with interest or importance. When that has been done the need for the adjective often disappears; and if it cannot be done the adjective is a meaningless platitude.

The following examples show some remedies for this fault:

The *most important* [best] route across the region.

The most *important* [abundant] igneous rock in this area.

The outcrops are few and are of little *importance* [interest] except for the *interesting* contact they show.

These streams, named in the order of their *importance* [size], are * * *.

Occur

The word "occur", meaning to appear or to be present, is very much employed in geologic literature but is used in many places with doubtful propriety where better words may be substituted. "Occur" is a proper and useful word, but there is no good reason for employing it in such sentences as these:

Trees *occur* [grow] on these slopes.

The mines *occur* [are] in Pope and Hardin Counties.

Water fowl *occur* [may be found] here in enormous numbers.

A well-exposed occurrence of dolomite sheared and made slaty by faulting *occurs* [is well exposed] north of Pequea Creek. (The correction, besides getting rid of the "occurrence * * * occurs", substitutes a definite subject nominative for the somewhat vague "occurrence.")

Section

"Section" is a word of many meanings, and its use in the sense of "area" or "region" should be avoided. The "section" of one sentence is likely to become the "region" of the next, as in "This mine is in the

[36] Gilbert, G. K., Interesting and important facts: Science, new ser., vol. 21, no. 524 pp. 68–69, 1905.

largest lead-producing section of Canada. This region is mountainous." In geologic reports "section" may with advantage be reserved to designate a land section, vertical section, cross section, and thin section, and perhaps for a few other uses, and "place", "locality", "area", "quadrangle", "district", or "region" may serve as geographic terms. If a distinction is needed it seems desirable to use "region" for the larger unit and "area" for the smaller.

Proposition

A "proposition" is something proposed. The expression "a good commercial proposition" for a business venture that is likely to be profitable is "curbstone English" that should have no place in a scientific report. "The project will probably pay" is shorter and better than "The project is a good commercial proposition." The sentence "These dikes are possible large low-grade propositions" is only one of many such sentences found in Survey manuscripts.

Following

"Following" is undesirably used for "after", as in the sentences "Following this there was a second period of uplift"; "Following the completion of this work nothing further was done." This use of "following" may be due to contagion from bad practice, as in the sentences "Mr. Kellerman went West following a prolonged illness"; "O'Brien left the place following his dinner" [seasick and jumped overboard?]. The phrase "during and following the interval" is objectionable both because "following" is not a preposition and because the similarity of ending makes "during" look like a participle.

Suffered

"Suffered" is a favorite word with some writers on geology, who often misuse it, as in "The deposits have suffered to some extent from erosion"; "The rocks have suffered much less from deformation"; "These rocks have suffered so much from metamorphism." (See "The pathetic fallacy", p. 66.)

"Other acidic rocks were injected after the schist had undergone most of the metamorphism which it has suffered" (=Other acidic magmas were injected into the schist after it had been metamorphosed almost to its present state).

Majority

"Majority", a good term for use at election time, is improperly used for "most", as in "The large majority of the grains range in size up to a quarter of a millimeter" (an altogether bad sentence) or in "Some of the ore has gone to other smelters, but the majority of it has been treated here."

The verb to be

The verb "to be" is best used to indicate existence or location. Its use as a principal verb in other connections is likely to make a flabby sentence, in which a word of more positive meaning could be substituted with advantage, as indicated below.

Much of its northwestern base *is* [consists] of quartzite.
Its steepest face *is* [fronts] toward the west.
Part of this adjustment *was* [was accomplished] through abrasion.
The only strong winds *are* [blow] from the southwest.
The presumptive origin *is by* [is to be ascribed to] faulting.
The principal gold production has been [obtained] from placers.

A few examples in which the use of the verb is unobjectionable will make the distinction clear:

Below the summit plain are valleys of gentle slope.
The remnants are on opposite sides of the fault.
The front tapeman should be a man of experience.

Effects of misuse

The misuse of words and phrases by the slovenly writer makes their proper use less effective, for the more careful writer, even with all his care, may fail to convey his ideas clearly to some of his readers because their minds have been dulled to the sense of propriety by general misuse. For example, the phrase "In regions approaching baselevel" in a paper by a careful writer has a distinct, exact significance, but as used in the paper of the slovenly writer it may mean merely "In regions that lie nearly at baselevel." The task of ferreting out the careless writer's meaning is thus imposed upon the reader, who, even with all his efforts to interpret obscure words or phrases, may fall into gross misunderstandings. The scientist who, in deprecating efforts to make his writings more easily understood, said of the prospective readers "Let 'em dig" perhaps realized that what he had to tell wasn't worth stating clearly.

Words and phrases to be discriminated

Terms of direction

Terms of compass direction—such as "west", "western", "westerly", "westward"—are by many writers used indiscriminately. "Five miles westerly from this place" is not so good as the familiar form "Five miles west of this place." The adverb "westward" means toward the west, or in a general westerly direction, the suffix "ward" having here its usual value, as in "homeward", "seaward", "skyward." In the sentences "This extends for an indefinite distance westerly" and "The stream here turns westerly" the word "westerly" should be "westward." In like phrases some writers use undesirably, as an adverb, not only "westerly" (a good adjective) but "westwardly" or "to the westward" or even "toward the westward." On the other hand, in such sentences as "Clay is abundant in this formation at Newton and westward" the adverb should be replaced by "farther west."

A similar variety of form is seen in phrases like "the southeast [or southeastern] corner of the quadrangle." Either of the terms here given may be admissible, but it is desirable that throughout a single paper such words should be used uniformly or consistently, or according to some principle or method. Indefinite or general terms of broad application may perhaps end in "ern", as "in the western part of the State"; terms of definite designation need not, as "on the south bank of the stream", "in the northeast corner of the quadrangle."

Puzzles in direction appear in many reports: "About 8 miles north and a little west of Weatherford"; "About 100 miles south of west of this"; "In a ravine 1½ miles west and a short distance north of Hanover"; "The specimens were obtained along Milk River about 30 miles north and west of Cut Bank and from Two Medicine River at a point about 15 miles south and west of the same town." In phrases like "10 miles north and 2 miles east of Alamillo" the "of" should be "from", as the distance is measured by starting from Alamillo and going first 10 miles north and then 2 miles east. The excuse for such an expression may be the fact that the place indicated cannot be reached by a bee-line diagonal, the roads being laid out along section lines.

Altitude and elevation

Both "altitude" and "elevation" are used in referring to distance above sea level, but as "elevation" also means uplift and is used in that sense in many geologic reports ("elevation of the two areas to their present altitudes"), whereas "altitude" as used in such reports has only the one meaning, there is a good argument for preferring "altitude."

Terms denoting time and place

Adverbs or adverbial phrases that by a strict definition should apply to time—such as "often", "sometimes", "at times", "always"—are by some writers used instead of words or phrases denoting place. Examples: "Pyrite is less common than marcasite, although it does occur at times, as, for instance, at the H. P. mine"; "This sandstone is usually gray but sometimes red in color"; "This rock is sometimes soft and sometimes well consolidated." The sentence "These crystals are sometimes an inch in diameter" was intended to mean "Some of these crystals are an inch in diameter." The sentence "These terraces are frequently covered with gravel" was written to convey the idea that certain terraces of a group are now covered with gravel, not that frequent floods deposit gravel on all the terraces. The idea in the writer's mind can be readily expressed by the sentence "Many of these terraces are covered with gravel." "These fissures often intersect" was written to mean "Many of these fissures intersect." "In summer these stream beds are often dry" has an obvious meaning, but it was intended to mean "In summer the beds of many of these streams are dry."

"The volcanoes are sometimes practically extinct" is an impossible statement: they might be sometimes quiescent and sometimes active, but if they were practically extinct they would be so without qualification. What the writer meant was "Some of the volcanoes are practically extinct."

Sentences like "These rocks are often red" and "The beds are often thick" can easily be made reasonable by proper correction. A magazine writer, perhaps to promote Pan American good feeling, says "The women of Chile are often beautiful", but he does not mention times or occasions, and if his remark were translated into Spanish, with the temporary form of the verb "to be" (están), which his "often" would require, his reputation among the fair Chileñas would be undone. The boy who was admonished not to eat mushrooms and was told that "people who eat mushrooms often die" may have been justified in asking "How often do they die before they stay dead?"

Some equivocal or undesirable terms appear in the following sentences:

These pebbles almost never have striated faces (=Few of these pebbles).

These rocks are nearly always red.

These veins can frequently be recognized at a distance.

These pebbles are usually light gray, though some are light yellow (=Most of the pebbles).

These phenocrysts are often deeply corroded (=Many of these).

As the moraine is rarely less than a mile and in many places 2 miles wide.

The general tone of the conglomerate is *usually* dark gray.

The complexity of the folding is *sometimes* [at some places] very marked, and complete details of structure at such places are difficult of discernment.

"When", indicating time, is misused for "where", indicating place:

When [Where] the thickness is greatest it is 250 feet.

The ore was richest *when* [where] it was most altered.

The limestones vary from light gray *when* [where] fresh to pale yellow where exposed to the weather.

Terms denoting place are sometimes misused in discussions relating to stratigraphy or to geologic history, as in the sentences quoted below:

The granitic intrusion probably occurred in *lower* [early] Jurassic time.

The beds may mark the *upper* [later] part of this general period of sedimentation.

"Shortly" is properly used for time but not for distance: "Shortly after" but not "shortly below" [a short distance below].

Part and portion; partly and partially

"Part" is generally preferable to "portion", and "partly" to "partially."

Part, the general term, denotes simply that which is or is regarded as being a constituent or fraction of a whole; a portion is a part regarded as more or less independent, or (especially) as assigned or allotted to some particular individual function, or purpose; as "All are but parts of one stupendous whole" (Pope). "The priests had a portion assigned them" (Genesis 47:22). "Art, thus conceived, realizes for men a larger portion of life" (Stevenson).—Webster's New International Dictionary, 1934 ed., p. 1781.

The two words are used properly in the following extract:

The Raton Mesa region is in the southern part of Colorado and the northern part of New Mexico. The Colorado portion is generally known as the Trinidad field and the New Mexico portion as the Raton field.

The reason for preferring "partly" is thus expressed:

"Partly" in the sense of "in part" is preferable to "partially", for partially also means "with partiality."—A. S. Hill, The principles of rhetoric, p. 19.

"Partially" is common in the sense of not "wholly", but good use restricts "partially" to the sense of "with partiality."—A. S. Hill, The foundations of rhetoric, p. 132.

Verbal and oral

"Verbal" is misused for "oral", which signifies "spoken."

"Oral", "verbal" are often used as equivalent terms. But oral applies only to that which is spoken by word of mouth.—Webster's New International Dictionary, 1934 ed., p. 1712.

"Oral" applies to that which is given by spoken words in distinction from that which is written or printed.—Standard Dictionary, 1913 ed., p. 2642.

"Verbal" is much used for "oral", as "a verbal message"; and sometimes for "literal", as "a verbal translation." It is an old and proper rule of rhetoric that when of two words or phrases one is susceptible of two significations and the other of only one, the latter, for the sake of avoiding obscurity, should be preferred. By this rule we should say "an oral message", "oral tradition", "a literal translation."—Century Dictionary, 1911 ed., p. 6725.

"Verbal" is properly used in the sentence "The differences between the two accounts are only verbal"—that is, the ideas are practically alike, but the words are different.

Watershed and drainage basin

By some writers "watershed" is used in the sense of "drainage basin", but as "watershed" primarily means the divide separating one drainage basin from another and is generally used with that meaning, the use of this word in two senses results in uncertainty and confusion. It is therefore suggested that "watershed" be used for the divide and "drainage basin" for the area drained. The use of "drainage" for "drainage basin" is improper.

Since, as, and ago

"Since", which in its primary meaning refers to sequence of time and is likely to be so understood, is by some writers used in the other sense, where "as" or "inasmuch as" would prevent momentary ambiguity. In each of the following phrases the "since" would on first reading be taken to indicate time and should be replaced by "as":

Since these experiments were made to determine the order of solubility of the compounds studied.

Since the war in Europe has affected ocean transportation.

Since the Snow Storm mine ceased production and the Lost Packer mine shipped only a few cars of matte, the increase during the year was due to * * *.

Since it was exposed to wave attack even before the Koolau spurs, ample time has existed for the ocean to remove this segment of the dome.

In the following sentence "since" is used in two senses:

Since the ore is crushed some movement has taken place since mineralization. (The intended meaning was "The fact that the ore is crushed indicates that some movement" etc.)

"Since" and "ago" should also be discriminated. "Ago" refers to a point in past time; "since" to the time intervening between such a point and the present. "Since the ice uncovered the nunatak, not many decades *since* [ago]."

Like and such as

"Like" introduces a comparison with something else; "such as" introduces an example of the group itself. In "some of the cones, like Manana Island", the "like" puts Manana Island outside of the group indicated by "the cones"; in "some of the cones, such as Manana Island", the "such as" makes it one of the group. "Such as" may also be used, however, to introduce a comparison. "Cones such as are present in other areas" is equivalent to "cones like those present in other areas."

Begin and open; end and close

The verb "open" means primarily "to move [something] from its shut position"; the opposite verb is "close." This pair and the corresponding nouns "opening" and "close" are often used in a figurative sense where "begin" (or "beginning") and "end" would be more exact and therefore preferable, on the general principle that a word that has only the intended meaning is better than a word that has several meanings, of which only one is applicable at the particular place where it is used.

Vary and various

"Vary" is misused for "range", as in "The wells *vary* [range] from 100 to 300 feet in depth." "Various" is misused for "many" or "several", as in "Gold occurs here and there on the ocean beach and *various* [many] attempts have been made to recover it"; "Native arsenic was found at *various* [several] places."

Evidence and evidenced

"Evidenced" (a word to be avoided) is used for "shown", "indicated", "proved", or "evinced", and "evidence" is much overused, especially "fossil evidence." An explorer says, "No fossil evidence was found in the limestone", meaning no fossils, or no traces of fossils. Note also "These beds are entirely recrystallized and [contain no traces] *evidences* of organic remains *are lacking*", a badly written sentence in which continuity and proper emphasis are lost by an unnecessary change of construction. (See pp. 57–58). Instead of saying that a certain conglomerate contained pebbles of limestone a geologist wrote "In this conglomerate limestone pebbles were in evidence."

Over and more than

"Over" is used in many phrases where "more than" would obviously be preferable. In the following sentences the "over" and "under" are in confusing contrast:

The burning has advanced along the coal bed for a distance of over 1,000 feet and under 1,000 feet of overlying material.

The ore mined usually lies under more than 20 feet, and in some places over 100 feet, of sand and clay overburden.

The dolomite dips eastward under over 20 feet of muscovite-biotite schist.

"Upward of" is also used undesirably for "more than", as in "The project will cost upward of a million dollars."

"Over" or "above" may be used in a misleading sense in such sentences as "Oxidation extends to depths *above* [below, of more than] 2,100 feet."

Due and owing

The adjective "due" may be misused for the participle "owing", and "owing" may be misused for "due", as in the following sentences:

The Whittier School was injured by the earthquake, *due* [owing] to the fact that the building stood on made ground.

The injury was *owing* [due] to the earthquake.

The line of strike of each fault is very crooked, *due* [owing] to the fact that the faults traverse a rugged country.

This energy is immediately due to gravitation, but it is remotely *owing* [due] to the sun's heat.

Due [Owing] to irrigation, the discharge had increased by 1917 to 5,000 second-feet.

Other discriminations

"Something" is improperly used for "somewhat", as in "something more than 5 miles"; "similar" is used for "the same", as in the phrases "a similar distance", "a similar height"; and "the same" for "similar", as in the sentences "The same rocks form the foot of the Jumbo vein, 1,000 feet to the east"; "The same gravel is seen at Norwood, 2 miles farther south."

"Between" and "among", "each other" and "one another", "beside" and "besides", "balance" and "remainder", "liable" and "likely" may be discriminated according to rules given in the textbooks.

"Apparently" is by some writers used for both "seemingly" and "obviously", words of opposite or widely different meaning.

Short versus long words

A long word is not objectionable simply because of its length, but if a short word that conveys the same meaning is available it is ordinarily to be preferred. For example, "numerous" usually expresses no idea that is not equally well conveyed by "many"; "approximately" is generally no better than "about"; "during" can be replaced by "in" where the

idea of duration is unintended or unimportant. Moreover, the repetition of a short word does not divert the reader's attention as much as the repetition of a long word.

Superfluous words

Found to be, known to be

The word "found" intrudes without reason in phrases like "These rocks are *found* exposed at many places" and "The principal lakes *found* in this region." In the sentence "These lands *are known to* contain valuable deposits" the words in italic may be easily spared. "Known to be", "found to be", and "seen to be" are generally superfluous, as in the sentences "The St. Peter sandstone is *known to be* jointed in places"; "In this region the deposits are *found to be* more arenaceous." On the other hand, these phrases may be improperly omitted where they are required to complete the sense of a statement, as "Under the microscope the grains of sand are [seen to be] completely coated with iron", "The rich ore, when examined closely, *consists* [is seen to consist] of fine-grained drusy quartz."

Present, presence

"Present" is a prime favorite with many Survey writers but is generally superfluous, as in the sentences quoted below:

The undulating strata mark one of the many local unconformities *present* in the arkose.
Here cacti are *present in greater abundance* [more abundant] than on the plateau.
In most of its facies quartz is the most abundant mineral *present*.
The metallic minerals *present* in the ores.
Blocks of sandstone are *present* scattered over the surface.
The formation, *where present*, *varies* [ranges] from a few to 200 feet *thick* [in thickness].
In this area there are several irregularities *present*.
By this means some of the zinc *present* in the ores is saved.
The presence of open channels that extend downward to caverns may be seen at several places.
The *presence of the* other sulphides of copper were not noted in the district. (Wrong subject nominative but right verb.)

Situated, located

"Situated" and "located" are generally superfluous, as in the following sentences:

One of the domes is *located* in sec. 31; the other is *located* in secs. 3 and 4.
South of the axis of the principal anticline in sec. 13 there is *situated* a small syncline.
The outcrops are *situated* on the shore *and in* close *proximity* to deep water.
The largest of these outliers is *situated* 2 miles *to the* southeast*ward* of the canyon.
This field is *located* 3 miles north of Bristol.

All of

The word "of" in the phrase "all of" is generally superfluous.

As a popular idiom "all of" is used to emphasize the totality of that which is referred to, as "How many of these men did you see?" "I saw all of them." The best literary usage omits the "of" as needless, preferring "I saw them all." "I saw all [not all of] my friends once more."—Standard Dictionary, 1913 ed., p. 73.

"All" followed by "of": This construction is comparatively modern and is probably due to form association with none of, some of, little of, much of, many of. Rare except with pronouns, as all of it, of whom, of which, of them.—New English Dictionary, vol. 1, p. 226.

The first citation given above represents the judgment of many literary critics, a judgment based on the assumption that, in phrases like "some of", "many of", "one of", the word "of" is a partitive—that is, a term implying partition or denoting a part—whereas in "all of" no expression of partition is intended. "The whole of" has been criticized on the same ground. A critic writes:

One may say "the whole staff accompanied the general" or (for emphasis) "the whole of the staff", but it would be better to say "the entire staff" or "all members of the staff," not "all of the members of the staff." "I will take it all" is regarded as better than "I will take all of it."

But "of" after "all" should not be mechanically cut out. In the phrase "Many *but not all* of these fragments are rounded" the italicized words may be superfluous, but whether or not they are cut out the "of" should stand.

Etc.

After phrases following "for instance", "for example", "such as", and like expressions "etc." is not only superfluous but improper, as in the sentences quoted below. (See also p. 99.)

Deposits of this type occur in several mines—for example, the Telegraph, Commercial, [and] Old Jordan, *etc.*

The solution contained mineralizers, such as fluorine, [and] boron, *etc.*

The glacial features that give variety to the surface, such as moraines, kames, [and] eskers, *etc.*, are described.

Superfluous prepositions

The use of a verb plus a preposition to express an idea that may be conveyed by some other verb alone may lead to the undesirable doubling of prepositions:

This can be *dispensed with* [spared] with advantage.

The conditions *met with* [observed, prevailing] in the field.

A large production is not to be *looked for* [expected] from these deposits.

Placer mining has been *carried on* [done] on this stream

In "a thickness of from 2 to 4 feet" the "from" should be omitted. So also in "the water rises to within 10 feet of the surface" the "to" is superfluous. Prepositions are doubled or tripled badly in the following sentences:

Each of the veins has been drifted on for from 50 to 70 feet [Drifts have been run on each vein for 50 to 70 feet].

This well was *brought in* [completed] in 1901.

This is equivalent to coal at *at least* $18 [or more] a ton.

A newspaper account of a new flying boat announced that "it will cross the Atlantic in *from between* 12 to 15 hours", using three prepositions where one would have been enough.

"Of" is superfluous after "permit", as in the phrase "too poorly preserved to permit *of* identification." "Admit" but not "permit" may be followed by "of."

"Of" is multiplied needlessly in many phrases, as in "An estimate of the cost of *the operation of* [operating] the filter." In most such phrases a noun ending in "tion" and the "of" following it should be replaced by a gerund ending in "ing." Many phrases in which "of" is repeated can be rewritten with advantage. "Following the discovery of the character of this deposit" means "After the character of this deposit was discovered."

Other superfluous words and phrases

Superfluous and improper words are italicized below:

Throughout *the whole of* the Mesozoic era.
Throughout the *entire* area.
A series of parallel ridges resembling in *their* form * * *.
The problem is *a* difficult *one*.
They are *both* alike.
There can be no doubt *but* that it is Cretaceous.
The steamer brings mail and freight to the *different* towns in the region.
The Survey has not *as* yet done any work in this region.
As yet no ore bodies of this type have [yet] been exploited.
The conditions were favorable for landslides *to occur*.
Equally *as* well.
It occurs in *disseminated* grains scattered through the rock.
Most of the intrusive masses are *of* large *size*.
The rock is dark green *in color*.
An innumerable *number of* tiny veins.
Bilateral asymmetry.
Contemporaneous *in age*.
The beds do not crop out *at the surface*.
This lies *on the* southwest *side* of the line of the fault.
The *color of the* fluorspar is dull green.
A report giving the results of the work is in *progress of* preparation.
Subsequent to the formation of [After] the Pleistocene terraces [were formed] *there has been* considerable phosphate [was] deposited *along the streams* in the *form of* flood plains and bars *of* [along] the present streams.
No *side* streams enter Red River from the north.
At its base the formation lies on a remarkably even surface of granite.
About a mile *in a* northwest*erly direction from* [of] Fort Bayard.
Lenticular *in character*.
Grass Creek almost bisects the basin *into two parts*.
In every respect except size the Ashe County deposits are exactly like *those exhibited by* the Cranberry deposit.
Minerals formed after the rock in which they are found *had preexisted*.
The *down*-dropped block. (An up-dropped block would be peculiar.)
The ores are of igneous origin *originally*.
The highest at 1,200 feet and others *at lower levels* down to about 1,000 feet above sea level. (Naturally others than the highest would be "at lower levels." The "above sea level" should be transposed after "1,200 feet"—with the first item to which it applies rather than the last. See p. 60.)

In addition another similar dike. (If it is "another" it is "in addition"; if it is "similar" it can't be the same one and therefore must be "another." "A similar dike" tells the whole story.

The phrase "as already stated" is generally unnecessary and undesirable. Repetition of a statement in another connection may be perfectly justifiable, but the reader need not be notified that it is a repetition—in fact, he may not realize it unless the author tells him. If it is desirable to make a cross reference to a place where the statement is given in more detail the form "as explained in detail on page —" or simply "(see p. —)" may be used.

Care is needed in using the connective term "as well as": in "complete as to maps as well as to text" the sense requires "as well as as to text", but to avoid the double "as" the second "to" may be omitted, or the phrase may be written "complete in maps as well as in text." The term "as well as" gives a slight additional emphasis to what precedes it compared with what follows it, and where no such emphasis is desirable "and" should be used instead.

Introductory phrases like "It may be said that", "It might be stated that", "Concerning this matter it may be borne in mind that", "In this connection the statement may be made that", "With respect to the occurrence of these ores it has been found that", perhaps intended to "break it gently" to the reader, are generally superfluous or can be replaced by single words, as in the following sentence: "*There can be little doubt that* this fissure is [doubtless] the prolongation of a fault *of the same character as the one* [like that] already described."

"During the winter months" or "in the summer time" are commonly used for "during the winter" or "in summer." Necessities of rhyme and meter may justify "the good old summer time", but Survey reports are not written in metrical form. "In the spring months" is not so common as "in the summer months" but is just as reasonable in phrases where "days" or "weeks" might with equal impropriety replace "months."

Words improperly omitted

Occasionally an author omits a word or words that may be needed to make a sentence complete. In the following sentences principal verbs have been added in brackets to the auxiliaries used: "The work was [done] for the State Survey"; "These surveys were [made] for economic reasons"; "The copper produced in Montana is [derived] almost entirely from the mines at Butte." (See also, "The verb to be", p. 82.)

An infinitive is omitted from the following sentence: "The outcrop is reported [to be] traceable for 70 feet."

Essential words are omitted from the sentences quoted below:

The work has been carried on under the general supervision of John Smith, [who was] assisted by William Jones.

The rock is confined to comparatively small areas on Racetrack Creek near [the point] where it leaves the quadrangle.

These sediments show [that] the Black Point basalt is as old as the Waimanalo stand of the sea. (Some writers also improperly omit the "that" after such verbs as "believe" or "indicate.")

The following analyses *are* [represent specimens] from mines in the active part of the region.

The following sentence shows both defect and redundance:

These rocks contain a few rusty-weathering beds [whose color is] due to *the abundance of pyrite in these particular beds* [the abundant pyrite they contain].

"The work done was under the supervision of" should be "The work was done under the supervision of."

Grammatical errors and problems

Elementary errors

The manuscripts of Survey reports contain relatively few of the commonly recognized grammatical errors. Some elementary errors appear, such as that seen in the sentences "Lake Superior is the largest *of any* lake in this region", "The timber in this area is the least marketable *of any* in the region", and "The Galena and Niagara dolomites have the greatest lateral extent of *any* [all the] formations in the area."

The use of participles

Participles are misused in many sentences where the participial phrase should form a logical continuation of the preceding phrase or clause, explaining or amplifying it or so relating to it that the propriety of using the participle cannot be questioned. In each of the following examples the participial clause simply makes an additional statement that has no logical relation to the clause to which it is added:

Pine Bluff is the natural business center of the southeast half of the State, the average temperature being 62°.

It is thin and slabby, weathering to a cinnamon color.

The sandstones are more or less massive, occurring chiefly in the lower half of the formation.

The discharge of the spring is about 8 gallons a minute, its temperature being 90°.

Much of it is perfectly transparent, the oval grains being one-fourth inch in diameter.

Douglas fir grows between altitudes of 6,500 and 8,000 feet, the individuals averaging 16 to 18 inches in diameter.

The palate is long and narrow, *the roof of the same being* [and its roof is] strongly arched.

A Washington newspaper writer perpetrated this sentence: "There have been many attempts to fix the value of the Tredegar estates, the accent being on the second syllable of the name."

The participle "affirms a state or action about something named by a substantive." [37] Except in the "absolute construction" (see below) the substantive (noun) should be included in the sentence as the subject

[37] Bates, Arlo, Talks on writing English, 2d ser., p. 35, 1901.

nominative of the clause to which the participial clause is attached. The following examples show failure to observe this requirement:

Where the till is thick *it is lighter in color* [its color is lighter], indicating less perfect oxidation. (The color indicates, not the till.)

The slopes are covered with debris, *thereby effectively concealing* [which effectively conceals] the coal beds. (The debris, not the slopes, conceals.)

These wells range in depth from 97 to 1,500 feet, depending on location. ("The depth of these wells ranges," etc. The depth, not the wells, depends.)

The dangling or hanging participle also represents a violation of the requirement stated above. A few bad examples may be cited:

Recognized as a bureau of information, *the services of* [it has to employ] two men *are required* to answer questions relating to topography alone.

Looking closer, chatter marks were seen (=Closer inspection showed chatter marks).

Examined carefully [On careful examination] no fossils were observed.

Approaching the vein [As the vein is approached] through the tunnel the serpentine is seen to be decayed.

After *entering* [the drill entered] the Alum Bluff formation a thick bed of clay was encountered.

Judging from the dips in the tuff [indicate that] a small hill has been mantled at this place.

Not satisfied with this result the well was drilled deeper (=Not satisfied with this result, the driller sunk the well deeper).

In the sentence "In going seaward the boulders become smaller" the participle "going" seems to relate to "boulders," but the writer meant "Toward the sea the boulders become [or are] smaller."

The participle in the following sentence may perhaps be used, if the added bracketed phrase is inserted: "Lakes are plentiful [and exhibit a wide range in altitude], occupying basins 100 to 2,000 feet above sea level." Without the bracketed phrase the participial clause is simply an added statement having no logical connection with the main clause.

In the "absolute construction" the substantive to which the participle relates is included in the participial clause, which expresses a condition or action that has some bearing on the main statement of the sentence. This construction is rare, and the more direct phrasing suggested in brackets in the following example seems preferable: "*The difficulties being* [As the difficulties are] by no means insuperable, however, a satisfactory interpretation may be worked out."

In many sentences a participle may be replaced by a defining relative clause (see pp. 96–97) with a slight gain in emphasis and possibly in clarity:

A gravel-floored plain *sloping* [that slopes] gently toward the southeast.

All the thick coal beds *cropping out* [that crop out] in this field.

Corrections involving participles have been indicated in the sentences quoted below:

Narrow box canyons extend into the range from the southwest, *heading* [and head] against long valleys from the opposite side, thus affording low divides easy of passage.

They are therefore regarded as *being* of the same geologic age.

The basal formation of the group here *occurs resting* [rests] upon the Tejon formation.

These dikes *were found cutting* [cut] the granitic intrusives and *were noted cutting* the aplite dikes.

Remnants of quartzite *occur perched* [lie] along the crest of the ridge.

The cliff *rises facing* [faces] the river.

Singular or plural number

Many writers appear to be in doubt whether certain nouns should take singular or plural verbs. The word "number" is itself an example. Both the following sentences are correct: "The number of men employed was greater in 1915"; "A large number of the men were injured." If the thing or things represented by the noun or by the subject is viewed as a unit, the verb should be singular; if the things are considered separately, the verb should be plural. The following sentences are correct:

He thinks that 30 cents is a high price.

Three dimes were placed on the table.

It is reported that 15 barrels of oil stands in the well (that much oil, not 15 separate barrels; there were no barrels in the well: the barrel was simply a unit of measurement).

At this place 20 feet of sandstone is exposed.

About 3,000 tons was produced in 1934.

The term "United States", treated as a plural in the Constitution, is now generally used as a singular. Ramsey [38] says:

The change is as much political as grammatical. In the early days of the Republic the plurality of origin was kept more before men's minds than the unity of result. They emphasized the "pluribus" of the common motto rather than the "unum"; but since 1865 there has been a greater feeling of nationality.

Some writers have difficulty with firm names. "Southern Pacific Co." is singular; "D. Appleton & Co." is plural. Uncertainty may lead to treating a name as both singular and plural in the same sentence:

The Illinois Central System announces the installation of air-conditioned cars on *their* [its] Chicago-New Orleans trains.

"None" may be used in either a singular or a plural sense. "Did you get some cottage cheese? None was to be found." "Did you get some strawberries? None were on sale." The Standard Dictionary says:

When the singular or plural equally well expresses the sense, the plural is commonly used. "None of these words are now current."

Antecedents

Relative and demonstrative pronouns and other words that require an antecedent are in many sentences left without one, or the grammatical antecedent is not the true one.

The basins receive much of the run-off of the adjacent mountainous catchment areas, in which many streams rise, but which discontinue when they reach the margin of the desert. (Grammatically both the first and the second "which" refer to "areas", but the second one was intended to refer to "streams". The last clause may be changed to read "but these streams carry water only as far as the margin of the desert.")

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[38] Ramsey, Samuel, The English language and English grammar, p. 274, 1892.

A nine-span steel highway bridge, three of which are over the normal river channel. (The grammatical antecedent of "which" is "bridge"; the real antecedent is "nine spans" and must be expressed in that form. Write "a steel highway bridge of nine spans, three of which", etc.)

With it there is much spotted ore that could be concentrated, but that has not yet been undertaken. (The "that" in the last clause has no expressed antecedent and should be changed to "concentration", or "concentrated" might be changed to "treated by concentration", thus providing an antecedent for the "that."

They enable stock to spread out into territory immediately after a rain which they are unable to graze in normal times. (As the nearest noun is naturally taken for the antecedent of a relative, the words "into territory" should be transposed just before "which.")

The lower salt series, which was deposited upon the Delaware Mountain formation in the Delaware Basin and which it filled to overflowing * * *. (The second "which" does not refer to "lower salt series" but to "Delaware Basin"; change "it filled" to "filled the basin.")

A succession of relatives, each referring to a different antecedent (a sort of échelon arrangement), makes an awkward sentence. The following example shows how the "which" used three times can be reduced to one:

Among the steeper dips north of the synclinal axis are those *which occur* along the southeast flank of the Hamilton dome, which, like the Bell Rock dome, is situated upon the axis of an anticline *which* [that] almost parallels the Round Bottom syncline.

A word that has to refer back to an antecedent of its own should not be made to serve as an antecedent for another word that follows. The weak construction that would result is shown in the following example:

These men had been appointed commissioners by the King, to determine all controversies in the colonies. The matter was referred to them, who after a full hearing determined * * *. ("Them" is an inadequate antecedent for "who"; write "and after a full hearing they determined", etc.)

Other troubles with antecedents are indicated below.

Probably less than two dozen cottonwood trees occur along the San Juan at and below Piute Farms, yet they are numerous in some of the side canyons. (The antecedent of "they" is "less than two dozen cottonwood trees"; change "they" to "cottonwoods." (See "Forgetfulness of subject nominative", p. 56.)

During early Tertiary time an area beneath the present mountains was domed, possibly by a deep-seated intrusion. This dome * * *. (No dome had been mentioned; change "This dome" to "The dome thus formed".)

Dry Creek and Cottonwood Creek contain many pools of alkaline water which are unfit for drinking. (The writer thought his "which" had to refer to "pools", but it was the water, not the pools, that was unfit for drinking. Put a comma after "water" and change "are" to "is.")

The basal beds rest unconformably upon those of the Fort Union formation. (The antecedent of "those" is "basal beds"; omit "those of.")

The variation in thickness seems to be due to erosion, for the sandstone rests on it with irregular contact. (The real antecedent of "it" is not "variation" but "the shale" in the preceding sentence. Change "it" to "the shale.")

Only one bear was seen, and their signs were not at all common. ("One bear" is not a sufficient antecedent for "their"—in fact, even a dozen bears that were seen wouldn't be a sufficient antecedent: it was the signs of the unseen bears that were not common. Change "their signs" to "signs of bear.")

The author of an "English grammar" writes, "I know of hardly any words that ought to be abbreviated; and if these were not, it would be all the better." Change "hardly any" to "very few"; "these" needs a positive rather than a negative antecedent.

It seems incredible that the following sentences should have been written while the writer was awake:

Many minerals were named after the discoverers. Among these could be mentioned wollastonite, hatchetine, and wernerite, who had described their properties. (Insert "named after the men" before "who.")

From April to October there are few wholly clear sunny days, a large number of them being cloudy or foggy. (The antecedent of "them" is "wholly clear sunny days", and the writer therefore trips over himself by saying that many sunny days are cloudy. Change "a large number of them" to "many of the days.")

Especial care should be taken in the use of "it." Carelessness produces a misfit, obscure sentence:

The bottom of the valley of Rosebud Creek has an altitude of 3,700 feet at the south line of the reservation. It flows in a narrow valley, and its tributaries are short and steep. ("It" and "its" refer to the creek, not to the bottom of the valley. The second sentence should read, "The valley is narrow, and the tributaries", etc.)

If a public well should encounter an open passage in limestone into which a drainage well carries sewage, typhoid may be communicated to hundreds of its citizens, even though the town might be miles from the source of contamination. (The antecedent of "its" is "a public well"! Change "its citizens" to "citizens of the town" and "the town" to "it.")

The origin of this fragmental texture has been variously explained. It has been argued by Hubbard and others that part of it, at least, is erosion debris. (As the antecedent of the second "it" is "fragmental texture", the writer says that part of the texture is debris. Change this "it" to "the material.")

The last example also shows the fault of using "it" in two senses in the same sentence. A still worse example, in which "it" is used in three senses, may be quoted from a book on the style of one of the oldest and most respected magazines published in this country:

"Probably" differs so slightly, if at all, in meaning from "likely" that it is difficult to conceive a case in which it might not be substituted for it.[39]

In the following sentence "it" is used four times—twice impersonally and twice referring to the same thing:

It has not been possible to identify it with any of the described forms, and it seems to be so distinct that it is probable that additional examples could be recognized without difficulty.

The awkwardness could be cured by writing "It could not be identified with any of the described forms, and it seems to be so distinct that probably additional examples", etc.

That, which, and whose

The distinction between the pronouns "which" and "that" should be borne in mind, though critics may differ as to its importance. "That" is the defining or restrictive pronoun, to be used where the clause that

[39] Ives, G. B., Text, type, and style, p. 270, 1921.

it introduces is necessary to complete the meaning of its antecedent; "which" introduces some added or incidental information, which is not needed to complete the sense. This distinction is illustrated in the foregoing sentence. In "The house that Jack built" each of the dramatis personae is identified by a defining clause beginning with "that." For example, among all the forlorn maidens of that neighborhood, the one "that milked the cow with the crumpled horn" was the one who got kissed.

The distinction between "that" and "which" is rigidly adhered to by some critics, but considerations of euphony may make it desirable to substitute "which" for "that" in a sentence where "that" is used several times or in more than one sense. "That" cannot be substituted for "which", however, and in a defining clause that begins with a preposition "which" must be used: "The quadrangles of which maps have been published."

Either "who" or "that" may be used as a defining pronoun referring to a person.

"Whose" may be used to designate things as well as persons, as "The only State whose production exceeded * * *."

The phrase "and [or but] which [or who or whose]" requires a preceding relative to justify the "and." If none can be supplied the connective should be omitted and the sentence may need to be rearranged. In the sentence "This formation, a thick mass of shaly sandstone, and which preserves its character throughout the area" the "and" is redundant and improper and should be omitted, or the sentence might be written "This formation, which is a * * * and which preserves * * *." It is necessary to use "which" rather than "that" in a defining clause that is followed by an "and which" clause:

> The portion of South Australia which has been most favorable for human occupation and within which there has been the greatest density of population in post-Pleistocene time * * *.

Than does, etc.

In such a sentence as the following the "does" is awkward and usually unnecessary: "There is little in the Patoot flora to mark its occurrence 36 degrees farther away from the Equator than does the Ripley flora." Howells [40] wrote:

> He writes in more than one place such an uncouth clause as "Goldoni shows a truer insight into cosmopolitan life than does Moliere"; as if he did not know that the ellipsis was perfect without the auxiliary and were bound to hammer the sense into us with blows that battered his sentence out of shape.

The same criticism of course applies to the use of any other verb with "than."

The split infinitive

The "split infinitive", in which "to" is separated by an adverb or other word from the verb to which it relates, should preferably be avoided, notwithstanding the numerous examples of its use found in English

[40] Howells, W. D. in Editor's Easy Chair, Harpers Mag., March 1914.

literature by some eminent critics. Most of the "split infinitives" in Survey manuscripts are split without reason, to the detriment of the sentence in which they appear, as in "The miners intend to fully test this ground" (=to test this ground fully), and in "It was impossible to more rapidly perform this work" (=to perform this work more rapidly).

Other grammatical improprieties

The use of "are" with a singular predicate noun or of "is" with a plural predicate noun is awkward: "The stony matter is largely angular blocks of limestone." (Better "The stony matter is made up largely of angular blocks of limestone.") "The large accumulations of sawdust *are* [constitute] a serious evil."

The reflexive pronouns "myself", "himself" should not be used for "I", "me", "him": "Long, Williams, and *myself* [I] held a consultation"; "The p'ace was named by *myself* [me]"; "Lee believes that the locality [he] described *by himself* * * *."

It is better not to "carry along" a singular verb to a second subject in the plural or a plural verb to a second subject in the singular: "The region was uplifted and the streams [were] rejuvenated."

"Underlain by" (not "underlaid by") and "overlain by" are correct forms.

The multiple compound adjective and other faults

The clumsy multiple compound adjective is found here and there in some manuscripts. One author writes of "the alcoholic copper acetate ammonia solution method"; another refers to "the natural gas production report"; and still another mentions "the west border of Bear Valley report." After seeing these cumbersome phrases the reader will not be surprised to find a hydrographer noting that by some means "the farther downward passage of the water is prevented" or a statistician writing of a "list of refined petroleum producers." Other similar phrases are "calcite as an igneous rock making mineral"; "a series of deep well and other water analyses"; "the white arsenic producing plants"; "a 30-ton capacity lead smelter"; "large 4 to 14 feet wide bodies of milling ore"; "the 425-foot well water"; "a 300,000 kilowatt 70 percent annual capacity factor basis"; "an only 2 to 3 miles wide schist band."

Somewhat in the same fashion dates are used as adjectives, as in "the 1899 earthquakes in Alaska", "the 1912 results of primary triangulation." Instead of writing, in normal English, "The production in 1915 was greater than in 1914" some authors write "The 1915 production was greater than the 1914 production", with loss of emphasis on the terms compared. The writer of newspaper headlines has scant room in the column for his phrases, so we find "1915 speed champions", "Heart disease victim", "Probes excessive living cost", "War state exists" (meaning state of war). An item about a Washington lady who had expressed objections to unnecessary or perfunctory social visits was

headed "Useless calls foe." Such headings are perhaps excusable because of their necessary limitations, but they should not serve as models for scientific writing.

Latin and other foreign words and phrases

"Data" (in many papers wrongly qualified by "this" or "much" or other term of singular number) is overused by some writers, appearing in places where better words can easily be found, and other foreign words and phrases are by many writers unnecessarily used where suitable English terms can be employed. Among these words and phrases are "videlicet" (viz), "id est" (i. e.), "exempli gratia" (e. g.), "rôle", "débouchure", "in situ", "brochure." The following sentences can be rewritten entirely in English without disadvantage:

These oxides were carried away in toto.

Chalcocite enrichment is practically nil.

The surface bore prima facie evidence of freedom from erosion.

This formation was laid down in local troughs *the sag of which proceeded pari passu with the deposition of the sediments* [that sank as fast as the sediments were deposited].

The compacting of the sandstone appears to have *proceeded pari passu* [kept pace] with the leveling.

"Per contra", "lapsus calami", and other Latin phrases are in favor with a few writers, whose manuscripts contain false plurals like "lamina", "lamella", "foliae", and "septae" (for "laminae", "lamellae", "folia", "septa").

Even the generally meaningless "etc." can in many sentences be profitably replaced by significant English, as in "The gangue consists of quartz, *etc.* [and other minerals]"; "Damour, Hersch, *etc.* [and others]."

A scholarly critic [41] writes:

I do not say that "etc." is not to be used, but its use should be rare, and chiefly for the omission of parts of quotations and the like. When used by the author to eke out his own matter or to save himself trouble the reader is disposed to exclaim, "If you have anything more to say pray say it; if not, finish your sentence properly; 'etc.' conveys no meaning at all."

For the improper use of "etc." in phrases beginning with "such as" and similar terms see page 89.

Euphony

Many violations of euphony, so called, are of practical consequence because they divert the reader's attention from the substance to the style of a paper. Examples follow: "Crustal movements crushed and crumpled the Cambrian rocks"; "rocks of this character characterize the formation"; "the interval that intervened"; "the replacement in places took place"; "rocks that form two unconformable formations"; "a much larger and longer lived lake"; "not uncommonly conglomeratic"; "further fissuring, faulting, and fracturing"; "conglomerates with well water-

[41] Allbutt, Clifford, op. cit., pp. 158–159.

worn polygenous pebbles"; "a somewhat similar series of sediments"; "some with outlets and others without outlets"; "at the base of the diabase"; "analyses in uniform form"; "the experiments made may aid"; "so far as known none"; "he pointed out some points"; "all are altogether altered"; "more modern methods of mining and milling"; "minutely comminuted"; "as the process proceeded."

The following sentence seems to be "faulty" in more than one respect:

A dike of agglomerate in the Colorado Prince reverse fault has been faulted by a minor cross fault within the fault zone, due to renewed movement along the main fault.

A few more infelicitous examples may be added:

Although in both cases there are certain uncertainties due to the presence of form genera of uncertain botanical affinities,* * *.

Milky quartz with sparse chlorite and sparse pockets sparsely mineralized with pyrite.

As erosion proceeded the ore became shattered and scattered through the clay.

Inasmuch as much the same characteristics * * *.

Around these mountains lie low-lying lands.

Proper emphasis is one element of euphony. A flabby, feeble sentence that lacks emphasis can be changed to one that cracks like a whip by rearrangement or rewording. The following sentence is faulty not only in the rhyme of the two clauses but in the failure to bring out clearly the contrast between the two transporting forces:

Ice in motion in the form of glaciers and icebergs transports an important quantity of material, and the wind carries small quantities of very fine, light material. (Change as follows: "Considerable material is transported by moving ice in the form of glaciers and icebergs, and small quantities of very fine, light material are carried by the wind." The rewritten sentence gets rid of the rhyme, the meaningless "important", and the awkward doubling of "quantity" and "quantities" and gives the places of emphasis (at the ends of the two clauses) to the words that should be emphasized.)

Minor counsel

An author should avoid the use of phrases like "last year", "this year", "next year", "3 years ago." Before the report is printed "this year" may have passed, and "last year" may be "2 years ago." Write "in 1934"; "during the season of 1934."

"Leaser", a term used by some miners for "lessee", may be understood by others as meaning either "lessor" or "lessee." Use "lessee."

Write "strikes east", not "strikes east-west"; one direction is enough; and don't write "The stream here flows east-west."

Write "The strike is N. 40°–60° E." (not "40° to 60° E."); "The strike ranges from N. 10° W. to N. 60° E."—that is, in such phrases "to" should not be used unless it is preceded by "from."

It seems desirable to make a distinction between "contour" as applied to the surface of the earth and "contour line" as applied to a topographic map.

As the noun "outcrop" may be mistaken at first sight for the verb "outcrop" (as in "The rock outcrops in the stream bed are surrounded by gravel") the form "crop out" seems preferable for the verb.

"Comprise", which is derived from Latin words meaning to seize together, should preferably be used with a plural object—one thing comprises several things. Some writers use it undesirably for "constitute."

"Except" is shorter and generally better than "excepting." "Exceptions" should have a logical relation to something expressed in the sentence. In "The coast line is, with few exceptions, rocky" it is the rockiness, not the coast line, to which there are exceptions. Write "Except in a few places the coast is rocky."

Phrases like the following should be avoided:

"A deposit of this type is described by Fenneman from Boulder County." (For "A deposit of this type in Boulder County is described by Fenneman.") "This plain connects with that *described* in the Driftless Area [, described above]." "Roots in situ are described 10 feet below sea level" [in the Mermaids' Home Journal?]. Note also "Pyrite is not mentioned in the Erebus mine", a statement that might appropriately be headed "Keeping it dark."

In some manuscripts the terminations "ic" and "ical" are used indiscriminately, as "topographic, topographical"; "geologic, geological"; "petrographic, petrographical"; "paleontologic, paleontological." Uniformity is desirable in a single paper, and the prevailing tendency is toward the use of the shorter form. "Chemical" and "physical" are invariable, however, and both "economic" and "economical" are used, each with its own meaning.

The formation of plural nouns from adjectives, as "sedimentaries", "crystallines", "Paleozoics", "volcanics", "pyroclastics", "alluvials", is undesirable.

Avoid phrases like "titanites, rutiles, and quartzes", for grains or crystals of titanite, rutile, and quartz. Note also the undesirable form "corroded crystals of quartz and a few sanidines."

A noun used to define a color should be so specific in meaning as to leave no doubt in the reader's mind. For example, "olive" is often used as a color term, but as an olive may be green or brownish drab or even, if ripe, almost black, the terms "olive green" and "olive drab" should be used where applicable, and it will not be necessary to refer to the ripe olive for a color comparison.

A similar indefiniteness is seen in such phrases as "pebbles the size of nuts." The reader has no clue to tell him whether the writer was thinking of filberts, walnuts, or coconuts.

The following forms are recommended:

Half a mile, a quarter of a mile, three-quarters (or -fourths) of a mile.
East bank, side, end, corner, edge.
Eastern part, portion.
Easterly dip, direction, trend.
Eastward-dipping, -trending, -flowing.
Extends eastward.

Lies in contact; comes or brings into contact.

Dynamic metamorphism (not dynamometamorphism); dynamically metamorphosed (not dynamometamorphosed).

Shark teeth (not shark's teeth); fish scales.

At an altitude of 100 feet (not at 100 feet altitude).

Triassic time, Cambrian and Ordovician time (not times).

300 acres or more (not 300 or more acres).

From this place (not from here).

To a point near Akron (not to near Akron).

To and beyond the Snake River (not to beyond the Snake River).

Eastern Marquette County and western Delta County (not eastern Marquette and western Delta Counties).

In Placer and Nevada Counties and the southern part of Sierra County (not in Placer, Nevada, and the southern part of Sierra Counties).

Summary of the features of a good manuscript

A well-prepared manuscript submitted for publication by the Geological Survey exhibits the features indicated below:

1. It is typewritten on sheets of uniform size that have been kept flat, not folded or rolled, and that are numbered continuously. The margin of white paper at the top, bottom, and left is ample, and the lines are far enough apart to permit easy and legible correction.

2. It includes a title page, a table of contents (headed "Contents"), two lists of illustrations (headed "Illustrations"), one a carbon, and two lists, one a carbon, giving complete titles of the plates, with all explanatory matter that should appear on or below them. It does not include the illustrations themselves—the drawings and photographs—which are inclosed in a separate envelope or package. The pages of manuscript on which the headings appear are indicated by numbers in the table of contents, and the pages on which the plates are principally mentioned or described and those on which the titles for the figures are written are indicated by numbers in the list of illustrations. (See p. 5.)

3. It is logically arranged in divisions and subdivisions under not more than five orders of center headings and one order of italic side headings, and the headings designate the things described or discussed, not the discussion.

4. The relative rank of the headings is indicated by indention in the table of contents.

5. It contains references, in numerical order, to all illustrations, as well as full explanations of them or of such of them as may require explanation in the text.

6. It includes, in numerical order, at the proper places, the full titles of all text figures, in the exact form in which these titles should be printed.

7. Its citations or quotations from other books are literally correct, and the beginning and end of each extract are clearly indicated, either by quotation marks or by distinctive spacing of lines.

8. Its footnotes, which include the titles of all works or papers cited and the particular pages to which reference is made, have been verified by the author and are in the forms prescribed on pages 16–30.

9. Its tables, chemical analyses, and geologic sections are provided with headings and are written in proper form for printing. The summation or footing of every column of figures is correct.

10. Its geographic names are in the forms prescribed by the Division of Geographic Names or other designated authorities, and its geologic names have been examined and approved by the Survey's committee on geologic names. (See pp. 6–8.)

11. Its paragraphing has been carefully determined and indicated, so that few if any changes in this respect will be needed.

12. Its expression has been well considered and conforms to the following requirements:

(*a*) If the report is economic or is likely to be called for by untechnical readers it is written in simple, straightforward English with words in common use and of generally recognized meaning.

(*b*) It is written in the first or the third person, not in both.

(*c*) The subject and subject nominative of each sentence have been carefully chosen.

(*d*) As a rule the subject nominative stands at or near the beginning of the sentence; or at least it is not so far removed from the beginning by the introduction of adverbial or other clauses that the reader is long kept in suspense.

(*e*) Adverbs and adverbial or other qualifying phrases are put in proper places.

(*f*) If emphasis on some term or phrase is desired it is gained by proper arrangement, so that the emphatic word or phrase stands at the beginning or, preferably, at the end of the sentence or clause.

(*g*) Its author and the typists who wrote it have noted and profited by the suggestions and directions given in this pamphlet.

(*h*) It has been written with the fact in mind that easy writing is hard reading, and care has therefore been taken to consider the reader's requirements.

13. It has been read carefully in its complete form by its author, who at the same time had before him, for reference, the drawings and photographs intended for its illustration.

Typographic style

The publications of the Geological Survey conform in general to the Style Manual of the Government Printing Office. It is impracticable to quote here all the rules that affect Survey publications, but a few of the most common questions are answered below. An "Abridged Style Manual" that contains practically all of the larger book except the part that is of interest solely to printers is obtainable for 20 cents from the Superintendent of Documents.

Capitalization

Capitalize a descriptive term used to denote a definite region, locality, or geographic feature, also such terms in the plural:

Allegheny Front
Appalachian Plateau
Atlantic Coastal Plain
Badlands (South Dakota)
Big Horn Basin
Blue Ridge
Canal Zone
Cascade Range
Catahoula Parish
Continental Divide
Continental Shelf
Crow Indian Reservation
Driftless Area (Mississippi Valley)
Eastern Shore
Fall Line
Gulf States; Central States
High Plains
Lower Peninsula (Michigan)
Lycoming Township
Mount Rainier
Niagara Falls
North Atlantic States
Pacific Coast States
Potomac River Valley
Puget Sound
Rangeley Lakes
Rio Blanco and Moffat Counties
San Joaquin Valley
Skyline Drive
Thornton Gap
Tioga Pass
the West; the Southwest

Such terms as "district", "area", "region", and "province" and such geologic terms as "formation", "anticline", "dome", "fold", and "fault" are regarded as common nouns not forming a part of the proper name and are therefore not capitalized.

Appalachian province
Bar X ranch
Breckenridge district
Mud Lake area
Yukon-Tanana region
Cincinnati anticline
Lagarto formation
Nacimiento uplift
Vermejo Park dome
Williams Range fault

The iron and copper "ranges" of the Lake Superior region are not mountain ranges, and in writing of them the word "range" is treated as a common noun like "area" or "district" and not capitalized. These ranges are the Cuyuna, Gogebic, Marquette, Menominee, Mesabi, Penokee, and Vermilion.

Capitalize the word "The" forming part of a geographic name: The Dalles, The Weirs, The Hague.

Capitalize prepositions, such as "van", "von", "de", "d'", "da", "della", or "di", in foreign personal names if used without the forename, a professional title, or a title of nobility or of courtesy: Van't Hoff, Von Humboldt, De Verneuil, D'Orbigny, Da Ponte, Della Crusca, Di Stefano. Lower-case such prepositions if they follow the forename, a professional title, or a title of nobility or of courtesy: J. H. van't Hoff, L. G. de Koninck, Fischer de Waldheim, Alcide d'Orbigny, Señor da Yznaga, G. dal Piaz, P. del Pulgar, G. dell'Acqua, Capt. di Cesnola, Constantin von Ettingshausen. In American and British names follow individual usage, if ascertainable: Henry van Dyke, Reginald De Koven.

Capitalize the full names of organized bodies and the distinguishing substitutes for such names—North Carolina Geological Survey, Idaho

Bureau of Mines and Geology, Connecticut Geological and Natural History Survey, Hayden Survey, Fortieth Parallel Survey, the Survey.

In citations of books or articles capitalize only the first word, proper nouns, and proper adjectives. (See section on footnote and other citations, pp. 16–30.)

Capitalize the name of a phylum, class, order, family, or genus, but not the name of a species: Arthropoda, Crustacea, Hypoparia, Agnostidae, *Agnostus; Agnostus canadensis*, *Epigaea repens*, *Quercus palustris*, *Diplotrypa westoni*.

Coined terms derived from proper names are not capitalized: aviculoid, menodontine.

Capitalize a plural formed by adding s to a Latin generic name: Martinias, Bellerophons.

Do not capitalize derivatives of proper names no longer identified with the names from which they were derived:

babbitt metal	pitot tube
canada balsam	plaster of paris
carlsbad twins	portland cement
china clay	roman type
harveyized steel	taintor gate
india ink	venturi tube

Do not capitalize a common noun used with a date, number, or letter merely to denote time or sequence or merely for the purpose of reference, record, or temporary convenience:

chapter 3	page 245
class I	plate 23
collection 6812	section 10
exhibit A	table 19
figure 7	well 162

Abbreviations

Use the following abbreviations for names of States after the names of cities, towns, counties, reservations, or national forests; also lakes, rivers, or other natural features:

Ala.	Ga.	Minn.	N. J.	Tenn.
Ariz.	Ill.	Miss.	N. Mex.	Tex.
Ark.	Ind.	Mo.	N. Y.	Va.
Calif.	Kans.	Mont.	Okla.	Vt.
Colo.	Ky.	Nebr.	Oreg.	Wash.
Conn.	La.	Nev.	Pa.	W. Va.
D. C.	Mass.	N. C.	R. I.	Wis.
Del.	Md.	N. Dak.	S. C.	Wyo.
Fla.	Mich.	N. H.	S. Dak.	

Idaho, Iowa, Maine, Ohio, and Utah should be written in full.

Use "St." for Saint, but write "Fort" and "Mount."

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In references to public-land divisions use the following forms: "In the NE¼SW¼ sec. 25, T. 5 N., R. 14 E."; "in the N½ sec. 25"; "in sec. 25"; "secs. 2 and 3"; "Tps. 4 and 5 S."; "Rs. 14 and 15 W."; "T. 13 N., Rs. 7 and 8 E." Note use of "the."

Names of railroads should not be abbreviated. Use the correct form—"railroad" or "railway." If an old name must be used for identification give also the present name. The railway guide will settle most doubtful points of this kind.

Use "short and" (&) only in firm or corporate names: Allyn & Bacon, John Wiley & Sons, Chesapeake & Ohio Railway, American Security & Trust Co. Names of persons who are associated in scientific, literary, or similar companionships should be connected by "and": Gilbert and Brigham, Meek and Hayden, *Cyrtolites disjunctus* Ulrich and Scofield.

Use "etc.", not "&c." nor "et cetera."

Use "percent" only with figures: A small percentage (or proportion); 20 percent. Do not use %.

For "number" (meaning a serial number) use "no." (lower-cased unless part of a capitalized name), not #.

The degree mark should be used with figures in statements of dips and strikes, and the terms of direction should be abbreviated: A dip of 10° SE. (or 10° S. 35° E.); the strike is N. 55° E. (or N. 45°–70° E.); but the dip is southeast—that is, terms of direction should be spelled out unless figures are given.

Use "a. m.", "p. m." with figures denoting clock time (10:23 a. m.). Note use of colon.

In text use "feet" and "inches", not ′ and ″. Over a figure column use "Feet" or "Ft. in." Write "16 by [not x] 24 inches."

Write "above sea level", not "above tide" nor "A. T."

In text and indexes write names of months in full, but in tables, leader work, and footnotes, if day is given with name of month (Mar. 9, Sept. 26), use the following forms:

Jan.	Apr.	July	Oct.
Feb.	May	Aug.	Nov.
Mar.	June	Sept.	Dec.

In the text and in reading columns of tables, all units of measurement should be printed in full.

Where it is proper to employ abbreviations for the terms listed below, use the forms given.

B. t. u. for British thermal units.
C. for centigrade.
cm³ or cc for cubic centimeter.
cf. for compare.
F. for Fahrenheit.
feet b. m. for feet board measure, when used with figures.
f. o. b. for free on board.
kw for kilowatt.
op. cit. for opere citato (in the work cited).
percent (omitting period) for per centum.
R. R., Ry., for railroad, railway.
sec.-ft. for second-feet.
ser. for series.
sp. gr. for specific gravity.
U. S. Army for United States Army.

Omit periods after abbreviations of units of the metric system: mm, cm, kg, etc.

Abbreviate plate (pl.), figure (fig.), page (p.) if used in parentheses or in footnotes. (See also pp. 19–21, 39.)

Spelling and compounding

Webster's New International Dictionary is the authority adopted by the Government Printing Office for spelling and compounding and will be generally followed. Note the form of the words below:

acidic	clue	gage
acre-foot	debris	gastropod
afterward	downward	groundmass
airplane	draft	laccolith
aline	draw-down	ostracode
aluminum	drought	pneumatolytic
arrastre	échelon	poikilitic
asbestos	employee	porcelaneous
badlands	enclose	reconnaissance
baselevel	eolian	second-foot
boulder	esker	siliceous
briquet	farther (distance)	upward
cannot	further (not distance)	volcanism
canyon	fluorspar	vug
cerusite	forward	water-worn

Words combined to form a unit modifier immediately preceding the word or words modified are generally hyphenated:

flood-plain deposits	blue-green algae
40-horsepower engine	light-green clay
well-defined rating curve	medium-grained sandstone
bluish-gray shale	thick- to thin-bedded limestone

The hyphen is not used if the first word of the modifier is an adverb ending in "ly" or if the first word in a three-word modifier is an adverb that modifies the second word:

carefully prepared report
fairly well defined rating curve

If, however, the first word in a three-word modifier applies to the other two, the hyphen is used between those two:

thoroughly contact-metamorphosed rocks
a nearly right-angle bend

A chemical term used as a unit modifier is not hyphenated: iron carbonate water.

Compound color terms, made up of two color names or a color name preceded by a noun that indicates the particular hue, are not hyphenated unless the term becomes a unit modifier:

The shale is olive green to blue green.
Brick-red and chocolate-brown clays.

A compound adjective in which the second word is a past participle or a coined adjective in the form of a past participle is hyphenated unless derived from a solid compound:

case-hardened	single-spaced	lime-cemented
chocolate-colored	fine-grained	V-shaped
cross-bedded	fine- to medium-grained	wind-blown

Prefixes (except ex and self) and suffixes (except elect) do not ordinarily require a hyphen:

clockwise	nonmarine	self-interest
ex-governor	pluglike	unaltered
interbedded	president-elect	varicolored

A hyphen is used, however, to avoid doubling a vowel (except after the short prefixes co, de, pre, pro, re) or to prevent mispronunciation or misinterpretation:

micro-organism	antero-inferior
meta-andesite	re-treat (treat again)
ultra-atomic	non-coal-bearing rocks

Write trans-Atlantic, trans-Mississippi, trans-Pecos, pre-Cambrian, post-Carboniferous.

Rules for the use of hyphens in rock names, with examples, are given on pages 8–11.

Use of italic

Foreign words are printed in roman, not italic.

In lists the names of fossils are printed in roman; in the text the names of genera and species are printed in italic: *Inoceramus fragilis*, *Ostrea congesta* Conrad, *Productus*. Names of families and higher groups are printed in roman: Brachiopoda, Mollusca.

The words *See* and *See also* should be printed in italic in indexes, glossaries, and like matter.

Italic should not generally be used for emphasis: the matter should be so phrased that its emphatic part need not be indicated by a mechanical device such as the use of italic type. Fowler [42] says:

> It is an insult to the reader's intelligence to admonish him periodically by a change of type, like a bad teacher imploring his boys to attend for a moment, that he cannot safely go to sleep just now. * * * To italicize whole sentences or large parts of them as a guaranty that some portion of what one has written is really worth attending to is a miserable confession that the rest is negligible.

The columnist Heywood Broun, criticizing the use of italic, says, "A writer might as well shout 'Booh!' at a reader."

Use of figures

Decimals, degrees, measurements, money, percentage, time, and similar matter should be expressed in figures (10.75 millimeters, 27°, 45 miles, 3 cubic feet, 24 pages, $1.54, 17 percent, 8 hours). Figures are also used

[42] Fowler, H. W., A dictionary of modern English usage, pp. 304, 305–306, 1930.

for groups of enumerations in which any one is 10 or more, isolated enumerations of 10 or more, and serial numbers, but not for isolated enumerations of less than 10 (tested at 4, 28, and 160 days; 25 wells; locality 259; nine stamp mills).

As numbers are not printed in figures at the beginning of a sentence it may be desirable to avoid placing them first. In the sentence "Four thousand eight hundred and fifty tons was produced in 1906 and 5,180 tons in 1907" convenience of comparison, if no other consideration, would require that both quantities be expressed by figures. The sentence may be rewritten: "The production was 4,850 tons in 1906 and 5,180 tons in 1907." Arrangements of figures or numbers shown in the following examples should also be avoided if possible: "This makes the total mileage of levels run in 1906 38,307 miles"; "In 1906 464 tons was produced."

In writing decimals supply a cipher if there is no unit: 0.25; 0.900 fine; it costs $0.3365 a pound; scrap at 0.75 cent a pound.

Metric amounts should be given in decimals: 0.5 millimeter (not one-half), 1.5 liters (not 1½).

Write "half a mile", "a quarter of a mile", not "a half mile", nor "½ mile." Spell out fractions that stand alone, as "one-eighth", "three-fourths"; but write "3½", "1¾" where the fraction is joined to a whole number.

Use figures for meridians and parallels: 141st meridian, 40th parallel.

Write "June 20" (not "June 20th"), but "the 20th of June."

Write "2d" and "3d", not "2nd" and "3rd."

For a fiscal year, consecutive years, or a continuous period covering more than 2 years use the contracted forms "1934–35", "1890–91", "1916–27", "1900–10", "1907–8" (but "1900–1901", "1895–1902").

Spell the word indicating date in such expressions as "the early seventies", "it occurred in the eighties."

Spell enumerations preceding a compound modifier that contains a figure, as "twelve 2-inch planks."

Punctuation

Use a comma after the word preceding "and", "or", or other connective in a series of three or more words or phrases like "clay, sand, and gravel"; "the upper coal is 21 inches thick, the parting 12 inches, and the lower coal 18 inches." Use a semicolon before "and" if the other members of the series are separated by semicolons: "The sandstone is white, hard, and fine-grained; the shale is dark, firm, and even-textured; and the limestone is massive."

Use commas before conjunctions (such as "and", "but", "or") in a sentence made up of separate clauses, each with its own subject nominative: "The ore is of low grade, but it has been worked." Note, however, "The ore is of low grade but has been worked."

In the following sentence a comma should be inserted after "weeks": the sense is not "weeks and tents and frame buildings" ("shoes and ships and sealing wax"): "The population increased from 10 or 15 to about 200 within 2 or 3 weeks and tents and frame buildings of all descriptions were hastily erected."

In the sentence "Certain difficulties arose between the contracting parties and the work was abandoned" insert a comma after "parties": the difficulties did not arise between the contracting parties and the work.

One more example may be enough: "Hops and briars are twined about the shrubs [,] and flowers grow in profusion" (not "twined about the shrubs and flowers").

The presence or absence of the new subject nominative therefore determines the presence or absence of the comma. If, however, the first clause is preceded by a phrase that applies also to the second clause the comma should generally not be used: "East of Olinda the beds are somewhat coarser-grained and conglomerates are more prominent than west of Olinda."

Omit the period after "percent" and after numbers (1, 2, 3) that stand over columns in a table.

Nouns (including proper names) ending in s take only the apostrophe in the possessive case, singular or plural, as Jones', Stokes', Joneses'.

Use no period at the end of an equation or formula written on a line by itself.

Note the punctuation in the forms "T. 13 N., R. 8 E. Willamette meridian"; "T. 13 N., R. 8 E., Mount Diablo base and meridian."

A page reference should stand between parentheses unless it reads into the text: "This area is shown on plate 10 (p. 150)" (not "plate 10, page 150"); "shown on page 150."

Omit the comma between month and year if day is not given: January 1935.

A defining clause should not be separated by a comma from the term that it defines, but a comma should precede a clause that simply gives additional information that is not necessary to complete the sense: "The highway bridge 2 miles west of Absaroka"; "Cabin John Bridge, 10 miles northwest of Washington." The distinction has the same basis as that between "that" and "which." (See pp. 96–97.)

A famous "lexicographer" writes, "The Spanish explorer, Francisco de Coronado, set out * * * in 1540", but as Coronado was by no means the only Spanish explorer the commas before and after his name should be omitted. The sentence "To the great Frenchman, Cuvier, paleontology owes its beginning" shows the same fault: Cuvier was great, but so have been many other Frenchmen.

A series of adjectives that precede the noun they qualify should be separated by commas if they are coordinate in application, as "long, slender, tapering cones"; "lofty, rugged mountains"; "deep, narrow

canyons." If they are not coordinate they should not be separated by commas, as "yellowish-gray clayey sand"; "homogeneous earthy material"; "hard-drawn 19-strand No. 0000 copper cable"; "3-phase 60-cycle alternating-current generator." In these phrases all the matter that follows each adjective is a unit to which that adjective applies. In the phrase "a narrow, elongate muscular scar" each of the first two adjectives is superposed on the unit "muscular scar", and the phrase should be punctuated accordingly.

Clauses of the two classes discriminated follow: "Hard, impervious subsoil"; "hard clay subsoil." "Dark, fertile loam"; "dark sandy loam." "Short, swift streams"; "short tributary streams." "Long dry spell"; "long, tedious spell of dry weather." "A brief, interesting account"; "a brief typewritten account."

In "Chopin's most characteristic posthumous impromptu" the unit is "posthumous impromptu", and the insertion of a comma after "characteristic" would make the sense "most posthumous", which is of course absurd.

One who is in doubt concerning the punctuation of such a phrase should ask "How much of this phrase is a unit?" Some such phrases contain more than one unit. In "a 2-horsepower Fairbanks gasoline engine" there are three units—the last word, the last two words, and the last three words: the phrase describes an engine run by gasoline, a gasoline engine of Fairbanks make, a Fairbanks gasoline engine of 2 horsepower. No comma should be used just before a unit.

The following phrases are punctuated according to the rules given above:

Hard, compact quartzite sandstone.
Hard dark-gray fine-grained calcareous sandstone.
Tough, hard gray siliceous shale.
Gray, rusty-weathering quartzitic sandstone.
Gray carbonaceous fissile clay shale.
Dense blue-gray crystalline limestone.
Soft gray thin-bedded fine-grained ripple-marked cross-bedded limy sandstone.
Light-buff to white fine-grained quartz sandstone.
Massive cross-bedded fine-grained cliff-forming dark-red sandstone.
Buff crystalline siliceous limestone.
Drab indurated and nodular calcareous shales.
Thin-bedded shaly magnesian limestone.
General Electric ATB 750-kilovolt-ampere 189-ampere 3-phase 60-cycle 2,300-volt 18-pole revolving-field alternating-current machine.

Correction of proof

Printer's terms and practices

To the printer "copy" is manuscript or matter to be set in type. "The matter has been read by copy" means that the manuscript has been read aloud by a "copyholder" to a proofreader who has held the proof sheets in hand and corrected them to agree with the manuscript except so far as the forms used in the manuscript may contravene the prescribed rules of printing, for unless the matter is to be followed literally (marked "fol. lit.") the proofreader will correct obvious errors in spelling, capitalization, and punctuation.

The first proof taken at the Government Printing Office is called a "galley proof" because the type is assembled in brass galleys. The first galley proof is read by copy and corrected, and a second galley proof is then taken, revised (that is, compared with the corrected first galley), and sent to the bureau that furnished the manuscript. Proof received from the Government Printing Office is not read by copy in the Survey unless the author wishes to take that precaution himself. By bureau and printing office procedure, generally slow—exasperatingly slow to the author except while he is reading the proof—the matter gets by stages into first page and second page proof. The first page proof, after it has been revised with the galleys in hand and otherwise corrected, may be approved for printing if it bears only a few corrections, but generally a second page proof is requested, and this is ordinarily the final proof, in which, as a rule, only typographic errors can be corrected. The final proof is approved for printing and returned to the Government Printing Office.

The time that ordinarily elapses between the date of approval for printing and the date of publication may be several months, depending on conditions and other demands at the Government Printing Office. The printing of elaborate colored maps may require from 6 months to a year, and work on the proof of the text of a report may be finished long before the first proofs of the maps are received.

Few Survey reports are electrotyped, and consequently reprints are generally impracticable; moreover, colored lithographic maps cannot be reprinted except at disproportionate expense.

General rules

Galley proof will ordinarily be sent to the author; also page proof if desirable and practicable. The proofs will bear marks made by proofreaders and editors—corrections, suggestions, and queries. These marks should be carefully noted, and special attention should be given to queries—question marks on the margins of proof sheets opposite points at which doubt is indicated, inconsistencies are noted, information

is wanted, or blanks are to be filled. Failure to note and answer such queries may necessitate the return of the proofs to the author.

Only reasonable corrections can be made in the galley proof, not radical alterations; and only slight, inexpensive changes will be permitted in the pages. As a rule additions can be made only to the galleys. If a considerable amount of matter is to be added it should be written on a sheet or slip, which should be pinned (not pasted) to the galley proof, and the place at which the added matter is to be inserted should be clearly indicated. Proof should be corrected and returned promptly to the editor of the Survey, who has been instructed to conform strictly to the requirements stated in this paragraph and must ignore all corrections made in violation of them.

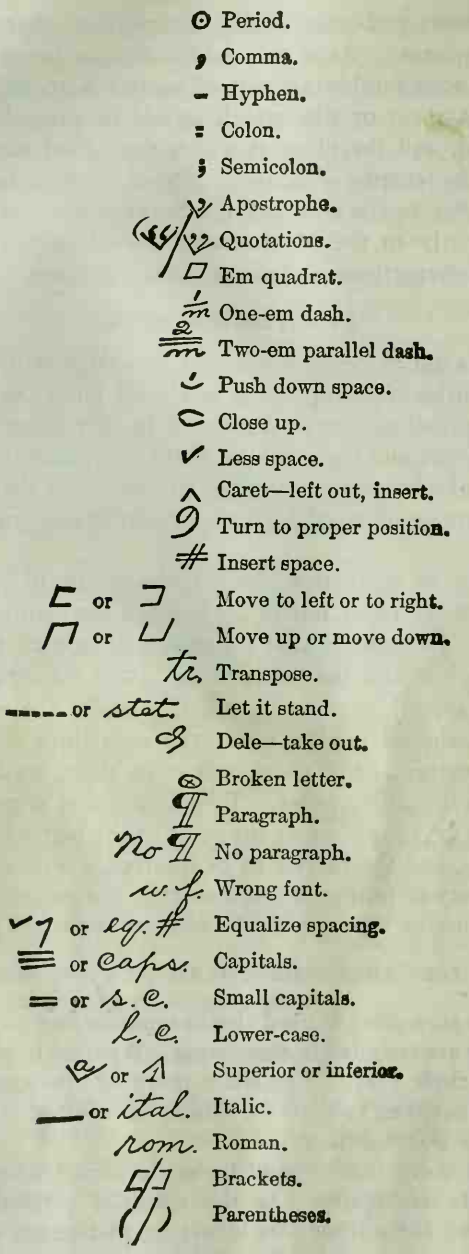
Proofreader's marks

Although it is not to be expected that an author will be familiar with all the technicalities of proofreading, he should know the use and significance of the principal marks employed in correcting proof, in order that he may understand the meaning of the signs made on his proofs and that he may make his own corrections properly. A list of proofreader's marks and a sample of proof marked for corrections are given on pages 114–115.

Every change or correction desired should be indicated by marks on the margin of the proof, not in the body of the printed matter, except as here noted. To indicate that something should be taken out, a line is drawn through it and the "dele mark" (ꝺ) placed in the margin of the proof. If something is to be substituted for the matter expunged the dele mark should not be used: the substitute matter should be written in the margin, or, if there isn't room there, on a separate sheet, to be pinned to the galley proof. To indicate that something should be inserted a caret (∧) is placed at the point in the text where the insertion should be made, and the matter to be inserted is written in the margin. It is not necessary or proper to put a caret in the margin also. Punctuation and other marks which might be obscure if written alone are placed to the left of the "stop mark", thus: ,/ ;/ -/ (comma, semicolon, hyphen). The stop mark is used also to separate one correction from the next where they are crowded in the margin. A period to be inserted should be placed in a circle (⊙). The space mark (#) indicates that a space, such as is used between two words, should be inserted at the place noted by a caret in the body of the proof.

All marks of correction should be made conspicuously and legibly, without possible ambiguity. As the editorial corrections are made with black pencil the author should use colored pencil or ink, in order that his marks may be readily identified.

The following are the marks commonly used by proofreaders to indicate corrections:



TYPOGRAPHICAL ERRORS

B.C. It does not appear that the earliest printers had any method of correcting errors before the form was on the press. The learned ~~The learned~~ correctors of the first two centuries of printing were not proofreaders in our sense; they were rather what we should term office editors. Their labors were chiefly to see that the proof corresponded to the copy, but that the printed page was correct in its latinity, ~~that the words were there,~~ and that the sense was right. They cared ~~but~~ little about orthography, bad letters or purely printers' errors, and when the text seemed to them wrong they consulted fresh authorities or altered it on their own responsibility. Good proofs in the modern sense, were impossible until professional readers were employed; men who had first a printer's education, and then spent many years in the correction of proof. The orthography of English, which for the past century has undergone little change, was very fluctuating until after the publication of Johnson's Dictionary, and capitals, which have been used with considerable regularity for the past 80 years, were previously used on the miss or hit plan. The approach to regularity, so far as we have, may be attributed to the growth of a class of professional proofreaders, and it is to them that we owe the correctness of modern printing. More errors have been found in the Bible than in any other one work. For many generations it was frequently the case that Bibles were brought out stealthily, from fear of governmental interference. They were frequently printed from imperfect texts, and were often modified to meet the views of those who published them. The story is related that a certain woman in Germany, ~~who was~~ the wife of a printer, ~~and~~ had become disgusted with the continual assertion of the superiority of man over woman which she had heard, hurried into the composing room while her husband was at supper and altered a sentence in the Bible, which he was printing, so that it read Narr instead of Herr, thus making the verse read "And he shall be thy fool" instead of "and he shall be thy lord." The word not was omitted by Barker, the king's printer in England in 1632, in printing the seventh commandment. He was fined £3,000 on this account.

4/?

Some don'ts on proofreading

Don't write corrections or additions in the body of the printed matter. Write them on the margins of the proof sheets, placing each correction opposite the line to which it pertains. Don't run "skyrocket" marks from the place where a correction should be made to a mark or added matter written at some distant place on the margin of the proof sheet unless there is no room for the correction opposite the line to which it belongs. Don't cross one "skyrocket" mark with another.

In correcting proof sheets don't put a caret (/\) in the text except where something should be added. Never put a caret in the margin. If anything in the text should be replaced by something else, simply make a mark through the matter to be replaced and write the substitute on the margin of the proof sheet, without making a caret anywhere. If something should be cut out (not replaced by something else) strike a mark through it and write in the margin the sign , a form of d, meaning delete (cut out).

Don't correct proof in the fashion attributed to a former President of the United States, who is said to have indicated a change from a semicolon to a comma by carefully erasing with his penknife the dot of the semicolon, without making any mark in the margin.

DIRECTIONS TO TYPISTS

Typists who are preparing matter that is to be printed should familiarize themselves with such parts of this pamphlet as are pertinent to their work. Especial attention should be given to the sections headed "The best printer's copy", "Table of contents and list of illustrations", "Tables and leader work", "Geographic names", "Hyphens in petrographic terms", "Quotations", "Footnote and other citations", and "Typographic style." They should also examine recent Survey publications, noting the style of the table of contents, footnotes, and other details and conforming their writing to that style. A few additional hints and some repeated directions are given below.

Use ordinary letter paper (8 by 10½ inches), and leave a margin of at least an inch at the top of the page, an inch at the left, and at least half an inch at the bottom. Every page should be numbered. Temporary page numbers should be placed at the bottom.

The title of the report should appear not only on the title page, but at the top of the first page of text—that is, the first page of the abstract—with the author's name below it, the name to be written between dashes, one above and one below, as shown on the first page of the text of all Survey publications. The title page should contain only the title of the report and the author's name.

In the table of contents, which should be headed "Contents", write main heads "flush"—that is, start them at the left margin of the writing; indent the others 5, 10, 15, or 20 spaces, according to their relations. Capitalize in the table of contents only such words as should be capitalized in the text. Use leaders to page numbers (see p. 5), which should be given, the pages being those on which the headings appear in the manuscript. If page numbers cannot be supplied when the table of contents is written they may be inserted with pencil later.

"Continued" lines should appear at the head of every page of a table of contents, to show the indention and relative rank of the items. Note the example below and see printed reports for examples.

Geology 36
Sedimentary rocks 36
Cretaceous system 36

Geology—Continued.
Sedimentary rocks—Continued.
Tertiary system 38

In the list of illustrations, which should be headed "Illustrations", use short titles only. Use capital and small letters, leaders, and page numbers as in contents. In this list write "Plate" and "Figure" in full, with the first plate and figure only. Observe and follow the style of recent printed Survey reports. Make a separate list for full titles of plates, containing explanations of details. Make carbon copies of both these lists.

For all headings use capitals and lower-case (small) letters; write nothing all in capitals. The relative rank of the headings should be shown by indention in the table of contents. (See p. 5.) Do not underscore or number the center headings, in either contents or text, to indicate their rank. Side headings should be underscored for italic, with period and dash after each heading.

The text of a report, including geologic sections, well logs, etc., should preferably be written triple-spaced; footnotes and quoted matter double-spaced. Leaving plenty of room for editorial marking may avoid the necessity of recopying edited pages, but a page with crowded interlineations, no matter how carefully they are written, must be recopied before it can be sent to the printer.

Write titles of text figures with "hanging indention" (see printed reports), not ordinary paragraphs nor each line flush.

Footnote references in the text should be unnumbered, but a "shelf" should be written for the final number, to be inserted later. (See p. 16.)

For reference marks in tables use "superior" figures (^{1}, ^{2}, ^{3}), not asterisk (*), dagger (†), etc. The references should be numbered in order, as explained on page 30.

Write each footnote in the line immediately below the line of text in which the reference mark occurs, separating it from the text above and below by lines running across the page; but do not break the text at the reference mark if it comes in the middle of a line.

See that the footnotes are in the forms prescribed on pages 16–30.

Rules for the use of hyphens in petrographic terms and a list of such terms are given on pages 8–11. Some other rules for the use of hyphens will be found on pages 107–108.

Use a comma after the word preceding "and", "or", or other connective in a series of three or more words or phrases like "clay, sand, and gravel"; "the upper coal is 21 inches thick, the parting 12 inches, and the lower coal 18 inches." Use a semicolon before "and" if the other members of the series are separated by semicolons.

Omit the period after viz, percent; also after numbers (1, 2, 3) that stand over columns in a table.

If a parenthetic reference to pages or illustrations is made at the end of a sentence, it should be enclosed within the sentence unless "See" is used: "Shown on the map (pl. 6)"; "the accompanying diagram (fig. 6)"; "referred to in another place (p. 127)." "The limestone is dolomized here as at some other places. (See p. 156.)" Note, however, "The reports of the *Challenger* expedition (see p. 118) contain valuable information on this point." Use "p.", "pl.", and "fig." for page, plate, and figure in parentheses, as shown above, but write in full in text: "This is described on page 93."

The heading for a table or section should be underscored for italic. See that units of measurement (as feet, inches, pounds, tons) are written

at heads of columns of figures representing such units. If dimensions are given in feet and inches use the form "Ft. in." for the units.

Use "etc.", not "&c." nor "et cetera."

Observe the general rules given on pages 108–109 for the use of figures and words to express numbers.

Write "half a mile", "a quarter of a mile", not "a half mile" nor "½ mile." Spell out fractions that stand alone, as "one-eighth", "three-fourths"; but write "3½", "1¾", where the fraction does not stand alone but is joined to a whole number.

Operators using keyboards bearing no figure 1 should use lower-case l for this numeral. If capital I is used confusion results, vol. II appearing instead of vol. 11, for example.

Write "16 by [not x] 24 inches."

Observe the directions given on pages 104–105 in regard to capitalization, and note the list of abbreviations of names of States given on page 105.

Use "a. m.", "p. m." with figures denoting clock time, and use a colon between hours and minutes (4:30 p. m.).

Write "June 20" (not "June 20th"), but "the 20th of June."

Write "2d" and "3d", not "2nd" and "3rd."

In copying manuscript "spell out" (that is, write in full or in words) any abbreviation or number that is encircled with pen or pencil mark, and write a small letter instead of a capital letter through which a vertical or diagonal mark has been drawn.

In copying matter that has been edited follow copy in all respects; do not change the style or punctuation. The editor has prepared the matter for printing, and disregard of his marks necessitates his doing the work twice. The marks indicating style of type need not be copied. Copied matter should be compared with the original before it is returned to the editor, and the original should be returned with the copy. Footnote numbers in text should be left blank. (See p. 16.) Carbon copies are not necessary.

As the printers require that no paragraph be carried over from one page to the next it is necessary for them to cut and paste manuscript to remedy such breaks in paragraphs. This task consumes much time and is therefore expensive and a source of delay; moreover, it produces sheets of different sizes, which are inconvenient to handle. For these reasons manuscripts intended for publication should be so written that no paragraph breaks at the bottom of a page. This plan requires looking ahead to determine whether the next paragraph can be finished on the page, and because some short pages are necessary it uses more paper; but these items are more than offset by the saving in expense, time, and convenience. If the author has written a paragraph so long that it will not go on one page the editor must apply the remedy; three or four lines may be written single-spaced to squeeze the paragraph into the page,

but if the paragraph is still longer the typist can do nothing about it. If she has written one or more paragraphs and miscalculated the length of the next so that it cannot be finished on the page, the sheet should be cut apart at the last paragraph, each portion pasted on a full-size sheet, and the paragraph finished with double spacing.

Note carefully the following "Don'ts":

Don't capitalize any words except proper nouns or proper adjectives in text, table of contents, list of illustrations, italic side headings, or titles for illustrations.

Don't use comma or period at the end of a line of matter that is followed or should be followed by leaders. (See sample table of contents, containing leaders, on p. 5.)

Don't begin a sentence with a figure.

Don't write one figure upon another so as to cover it and to produce an uncertain result, as a 3 upon an 8 or a 5 upon a 6. Erase fully the figure first written before correcting.

Don't use 〃 for "Do." or "do.", meaning ditto. In tables use "Do." (capitalized) in first and last columns; "do." elsewhere.

Don't use % for "percent", nor # for "no."

Don't underscore names of fossils when they are arranged in lists or in tables. In text underscore the names of genus, species, and variety (*Spirifer, Spirifer crispus, Spirifer crispus simplex*), but not the family, class, or other name (Lingulidae, Mollusca, Brachiopoda).

Don't underscore other foreign words for italic.

Don't underscore center headings, and don't fail to underscore side headings.

Don't put footnotes at the bottom of the page. (See p. 16.)

Don't paste sheets together except to make a table that must be wider than letter paper.

Don't write anything single-spaced except as indicated at the top of this page. (See pp. 3–4.)

Don't rewrite matter for the purpose of filling a sheet with typewriting. The printer will not leave blank spaces where they may happen to occur in copy. The rules that apply to letters in this respect need not be applied to manuscript intended for printing. The presence of erasures or of plainly written interlined words or phrases may be tolerated, and pages containing these need not be rewritten. A complicated table that has been prepared in ink need not be typewritten if the writing is plain in every part, but fine, crowded writing or pale blueprints cannot be accepted. The prime requisite is that the matter should be clearly legible.

Don't crowd anything to economize paper. It is impossible to make copy too plain, and room must be left for editorial marking. This direction applies to tables and footnotes as well as to text.

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O

DEPARTMENT OF THE INTERIOR
JOHN BARTON PAYNE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

THE PREPARATION OF ILLUSTRATIONS

FOR REPORTS OF THE

UNITED STATES GEOLOGICAL SURVEY

WITH BRIEF DESCRIPTIONS OF PROCESSES
OF REPRODUCTION

BY

JOHN L. RIDGWAY

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THE PREPARATION OF ILLUSTRATIONS

FOR REPORTS OF THE

UNITED STATES GEOLOGICAL SURVEY

BY

JOHN L. RIDGWAY

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THE PREPARATION OF ILLUSTRATIONS FOR REPORTS OF THE UNITED STATES GEOLOGICAL SURVEY.

By JOHN L. RIDGWAY.

PART I. PREPARATION BY AUTHORS.

INTRODUCTION.

There has been an obvious need in the Geological Survey of a paper devoted wholly to illustrations. No complete paper on the character, use, and mode of preparation of illustrations has been published by the Survey, though brief suggestions concerning certain features of their use have been printed in connection with other suggestions pertaining to publications. The present paper includes matter which it is hoped will be of service to authors in their work of making up original drafts of illustrations and to draftsmen who are using these originals in preparing more finished drawings, but it is not a technical treatise on drafting.

The effectiveness of illustrations does not depend entirely on good drawings nor on good reproduction; it may be due in large part to the inherent character of the rough material submitted. If this material is effective or striking the finished illustrations, if well made, will be equally effective and striking. Each step in the making of an illustration—first the preparation of the author's original or rough draft, next the final drawing, and last the reproduction—is closely related to the others, and each is dependent on the others for good results. If the material has been well handled at all three steps the resulting illustration should be above criticism; if it has been poorly handled at any one of the three the effectiveness of the illustration is either impaired or ruined.

A consideration of processes of reproduction is essential in the preparation of all illustrations, and the influence or effect of the process to be selected on the methods of preparing a drawing has seemed to warrant the presentation of brief descriptions of the processes usually employed by the Geological Survey. These descriptions include statements as to the kind of copy that is suitable for each process, the result produced by each, and the relative cost of the processes.

PURPOSE AND VALUE OF ILLUSTRATIONS.

An illustration in a report of the Geological Survey is not merely a picture having a remote bearing on the subject matter of the report; it must represent or explain something discussed or mentioned in order to become an illustration in the true sense of the term. The illustrations used in the Survey's reports are not employed for embellishment; the more pictorial kinds may be in some measure decorative, but decoration is distinctly not their primary purpose. The illustrations used in popular literature are designed to meet a public demand for ornament or attractiveness. Those used in scientific publications should be made plain and direct, without attempt to ornament or beautify. In the literature of science illustrations made by the reproduction of photographs or of explanatory diagrams or maps are intended simply to furnish greater illumination, and if the illustrations display photographic reality most statements or conclusions thus illuminated seem less open to dispute. A photograph may thus serve the double purpose of explanation and corroboration. The graphic expression of data and of details in a Survey report is intended to aid the reader in comprehending the report, and this is the prime advantage of its use, but it also enables the writer to omit from his text numerous descriptive details. It would generally be difficult without illustrations to present a clear picture of the geology of a region in its exact relations, and especially to describe adequately the form and the details of the structure of many fossils. The tasks of both the writer and the reader of reports on geology and kindred subjects are thus greatly facilitated by geologic maps, sections, paleontologic drawings, and illustrations of other kinds.

The responsibility for good and effective illustrations rests largely upon the author, who should select and plan his illustrations with a view to their utility in aiding the reader to understand his report.

SELECTION AND APPROVAL OF ILLUSTRATIONS.

There is no rule limiting the number of illustrations that may be used in a publication of the Geological Survey, but in selecting illustrations for a report an author may easily fall into the error of over-illustration. The number of diagrammatic drawings or of drawings that express the author's deductions is rarely in excess of the needs of a paper, but the number of photographs submitted is often excessive. The number of pages in a manuscript may be a factor in determining the proper number of illustrations, but as the need of illustrations varies greatly from paper to paper this factor alone is

not decisive. The tendency to overillustrate led the Director to issue the following order[1] governing the approval of illustrations:

> The primary responsibility for the selection of illustrative material shall rest upon the author and the chief of the branch transmitting the report. No one knows the subject matter of the report better than its author, though a sympathetic critic is usually needed to correct the personal equation that may express itself in an excessive number of illustrations or the use of photographs into which no one but the field man himself can read what he wishes to illustrate. The approval by the chief of branch of the illustrations selected by the author will be taken as vouching for those illustrations as essential and adequate, and the scientific value of the illustrations will not be subject to review in the section of illustrations.
>
> The chief of the section of illustrations shall decide the technical questions relating to the preparation of these illustrations for reproduction and may recommend the rejection of any that do not promise effective or economical reproduction. In the consideration of such questions, especially any relating to maps, the cooperation of the editor of geologic maps and chief engraver will be expected.

The judgment of an author as to the illustrative value of a photograph is likely to be biased by his knowledge of the features that are actually included in the view represented, not all of which may be shown clearly in the photograph; his knowledge of all the features enables him to see more in his picture than his readers will be able to recognize without detailed description. Photographs in which special or significant features are obscured by foliage or lost in hazy distance do not make acceptable illustrations, and the use of a picture that requires much description to make it illustrate reverses, in a measure, the relations of text and illustrations.

A photograph is not necessarily good for reproduction simply because it shows some particular feature to be illustrated; the quality of the print it will afford when reproduced from an engraved plate should also be considered. Some loss of detail by reproduction must be expected, and therefore only the clearest and most effective prints obtainable should be submitted.

If an author has difficulty in making his preliminary or "original" drawings he may request that a draftsman be detailed to aid him. The request should be made to the Director through the chief of branch and properly approved. The work will then be done in the section of illustrations as advance preparation, but finished drawings should not be thus prepared unless the conditions are unusual. The administrative geologist reviews all illustrations submitted and represents the Director in matters relating to illustrations.

[1] From Survey Order 63, Oct. 20, 1915.

SUBMITTAL OF ILLUSTRATIONS.

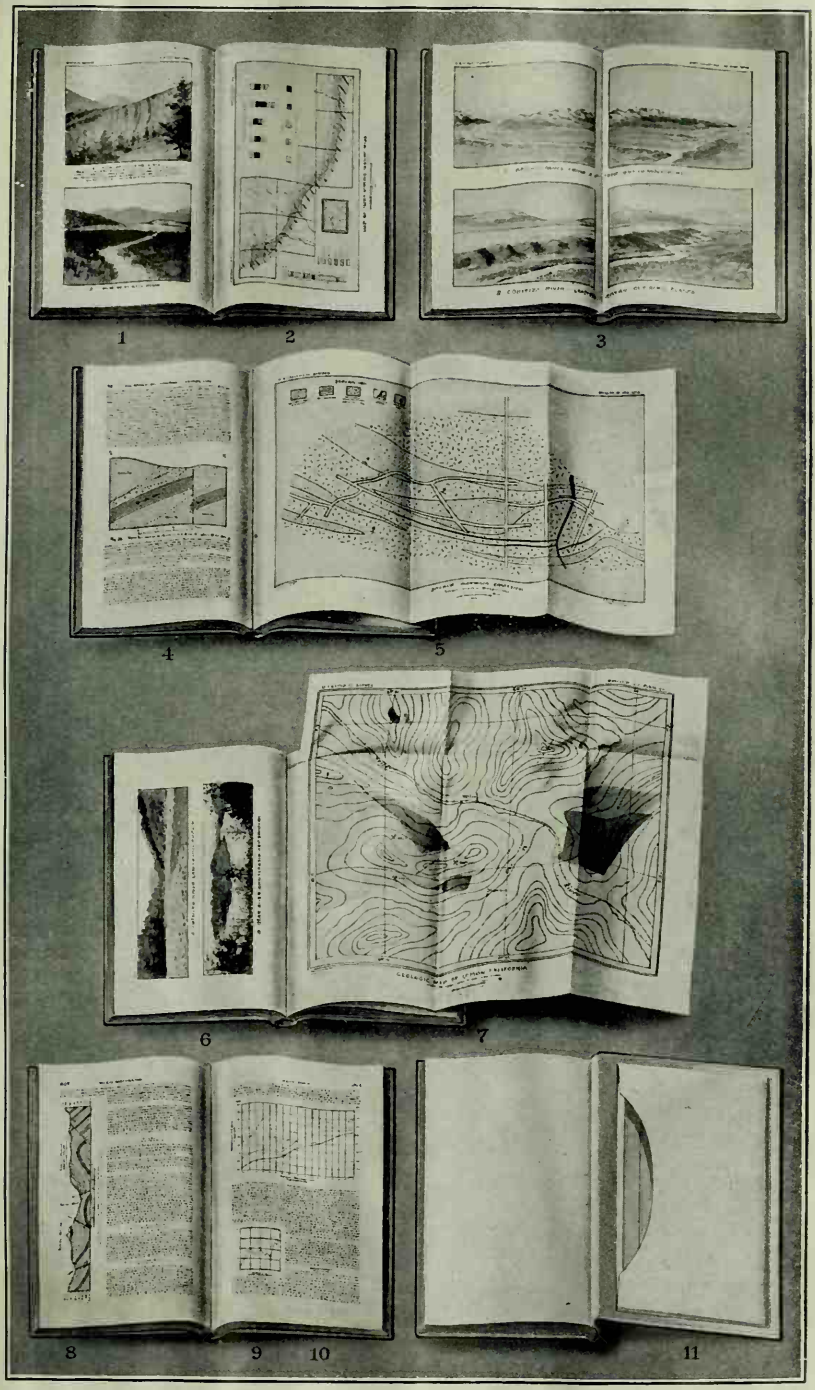
All material intended for illustrations, except paleontologic specimens, should be submitted with the manuscript of the paper to be illustrated but in a separate package marked "Illustrations to accompany a paper on —— by ——." The package should contain a carbon copy of the list of illustrations that accompanies the manuscript or, if the titles to be printed on or with the illustrations include fuller descriptions than are given in that list, a carbon copy of the list giving complete titles and descriptions, the original of which should also accompany the manuscript. In the list each plate and figure should be separately numbered consecutively in the order in which it should appear in the report, and a figure opposite each title should show the number of the manuscript page on which the illustration is first mentioned or most fully discussed. Roman numerals should be used for the plates and arabic numerals for the figures. Each drawing or photograph should bear, in addition to the number and title, any suggestions concerning preparation, reduction, and method of reproduction which the author may consider especially desirable. The list should be headed "Illustrations."

Specimens other than fossils that are to be illustrated must be submitted directly to the section of illustrations, but the author may first obtain photographic prints of them in order to make up his plates. The specimens should be carefully packed and any that are fragile should be so marked.

KINDS OF ILLUSTRATIONS.

The illustrations in reports of the Geological Survey may be classified into five more or less distinct groups—(1) maps, (2) diagrams (including graphs, sections, plans, figures of apparatus, and stereograms), (3) outdoor photographs, (4) photographs and drawings of specimens, and (5) sketches. These may be further divided into two large groups, which may be called permanent and ephemeral. The permanent group includes illustrations that do not lose value through lapse of time or by natural alteration, such as detailed geologic maps, well-prepared structure sections, views of specimens, and good photographs or drawings of natural phenomena; the ephemeral group includes maps showing progress, key maps, diagrams showing yearly production, and many others that should be prepared in such a way as to minimize cost of preparation and reproduction.

The illustrations will be finally divided into plates and figures when they are fully prepared, but if an author desires to determine the classification in advance of transmittal he should submit his material to the section of illustrations, where methods, processes, and reductions will be decided for each. In determining which shall be



METHODS OF INSERTING PLATES AND FIGURES.

1, 2, 3, 5, 6, 7, plates; 4, 8, 9, 10, figures; 11, pocket.

plates and which shall be figures, size and method of reproduction are the only factors to be considered; there are no other real differences. Illustrations that require separate or special printing, such as those reproduced by lithography and by the photogravure, photogelatin, and three-color processes, must be printed separately from the text as plates and inserted in the report at the proper places; those that are reproduced by relief processes, such as zinc and copper etching and wax engraving, if not too large, can be printed with the text as figures. If an illustration to be reproduced by a relief process is marked for reduction to a size not exceeding that of the page of the text, it can be called a figure and be printed with the text. Half tones, though etched in relief, are rarely made text figures in Survey reports, because to give satisfactory impressions they must be printed on the best quality of coated paper, which is not used for the text. By using the coarser screens shown in Plate VI (p. 56), however, a half-tone cut may be made that can be used in the text if it is smaller than the page.

SIZES OF ILLUSTRATIONS.

The regular book publications of the Geological Survey are issued in three sizes—(1) octavo (annual reports of the Director, statistical reports on mineral resources, bulletins, and water-supply papers); (2) quarto (professional papers and monographs); (3) folio (geologic folios). The following table gives the measure of the text of each size and the measure of the trimmed page, in inches:

	Size of text.	Size of page.
Octavo	$4\frac{3}{8}$ by $7\frac{15}{16}$	$5\frac{7}{8}$ by $9\frac{1}{8}$
Quarto	$7\frac{1}{16}$ by $9\frac{13}{16}$	$9\frac{1}{8}$ by $11\frac{3}{8}$
Folio	$13\frac{13}{16}$ by $17\frac{7}{8}$	$18\frac{1}{2}$ by $21\frac{3}{4}$

Most professional papers are printed in two columns of type, each 3 inches wide, and folios are printed in three columns, each $4\frac{3}{8}$ inches wide. A text figure in one of these publications can be made to fit one or more columns, and it may run the full length of the text page.

The limits of the dimensions of plates and figures, in inches, are given in the following table. If for any reason a plate can not be reduced to the dimensions of a page it can be folded once or more; and if it is large and unwieldy it may be placed in a pocket on the inside of the back cover. (See Pl. I.)

	Single-page plate.	Plate with one side fold.	Text figure.
Octavo	$4\frac{3}{8}$ by $7\frac{1}{2}$	$7\frac{1}{2}$ by $8\frac{1}{2}$	$4\frac{3}{8}$ by $7\frac{1}{2}$
Quarto	7 by $9\frac{1}{2}$	$9\frac{1}{2}$ by $14\frac{1}{4}$	$3\frac{3}{16}$ or 7 by $9\frac{1}{2}$
Folio	15 by $17\frac{1}{2}$	———	$4\frac{3}{8}$ or $13\frac{13}{16}$ by $17\frac{7}{8}$

For an octavo report a single-page plate with side title should be 4 inches or less in width, and a plate with bottom title should be 7 inches or less in depth. In other words, the actual depth and width

of a single-page plate in a page of any size must depend on the number of lines in its title, the inclusion of which should not extend the matter much, if any, beyond the dimensions given in the table. A difference of 1 inch or less in the width of a folding plate may determine whether it must be folded once or twice, so that by consulting this table an author may save expense in binding and promote the reader's convenience in handling the plate.

A text figure (including the title) can not extend beyond the text measure but may be of any size or shape within that measure, as shown on Plate I, figures 4, 8, 9, 10.

SUBDIVISIONS OF PLATES AND FIGURES.

If a plate consists of two or more parts or photographs each part should be marked with an italic capital letter—*A*, *B*, etc.—which should be placed directly under each. If it is made up of many parts, in the form of plates that accompany reports on paleontology, each part should be similarly marked with an arabic numeral—1, 2, 3, etc. If a text figure is subdivided into two or more parts, each part should be marked with a roman capital—A, B, C, etc.; and if details of a part are to be described each detail should be marked by an italic lower-case letter—*a*, *b*, *c*, etc.

PREPARATION OF COPY BY AUTHORS.

CHARACTER OF ORIGINAL MATERIAL.

In the Geological Survey, as elsewhere, the "originals"—that is, the original material submitted by authors for the illustration of their reports—differ greatly in character and in degree of clearness. Some are carefully prepared; others are rough, obscure in part, and defective in detail. Drawings made from poor originals progress slowly, because the draftsman spends much time in interpreting uncertain features or in conference with the author concerning details. An original should be perfectly clear in detail and meaning, so that the draftsman can follow it without doubt. It should not consist of parts that must be brought together to make a new drawing, because the result of the combination of the parts will be uncertain at the outset and may not prove satisfactory. Each original illustration should be prepared with the idea that the draftsman who will make the finished drawing will be unfamiliar with the subject and will need definite instructions; all data should be plotted and each figure or plate should be completely made up before it is submitted. More or less roughly prepared originals are expected, but they should show no uncertainty in details. Obscure features may be cleared up by in-

closing the features in penciled loops connected by a line with notes written on the margin, such as "omit this line," "turn at an angle of 30° from true north," "add," "cut out."

PRELIMINARY PREPARATION OF MAPS.

The base map that generally accompanies a report may be an original field sheet or it may have been compiled from various sources by an author and made to incorporate the results of his field work. It should not be a collection of maps of different scales and standards to be worked into a new map.

The source of the data shown on every original base map should be indicated on the map, whether it is to be used as an illustration or as a record of field work. This information is required as a permanent record for showing the reliability of the map, for use in comparing data, and for giving full credit to those who are responsible for the data. An author should see that this requirement is observed in order that proper credit may be given and should especially see that all cooperative agreements and organizations are properly mentioned.

An original map should preferably be complete in itself. It should not consist of several parts or sheets unless the data to be represented are unusually complex. All elaborate or technical finish of border lines, lettering, or like features should be left to the draftsman or the engraver.

Base maps that involve the compilation of new data should be prepared by either the topographic branch or the division of Alaskan mineral resources. If a base map already published is to be reused it should be submitted to the chief topographic engineer or to the chief of the division of Alaskan mineral resources for approval. This procedure will insure a single standard of geographic accuracy in maps appearing in Survey publications.

A geologist who requires a base map that includes new topographic data should address a request for its preparation to the chief geologist, who, through the Director, will refer the request to the topographic branch. The request must be accompanied by a full statement regarding the proposed report and the time when it is likely to be submitted. The preparation of such base maps by draftsmen in the division of geology, the land-classification board, the water-resources branch, or the section of illustrations has been discontinued except for the minor adaptations provided for above.

If a report requires the preparation of a base map that includes no new topographic data such a map must be compiled from other authentic maps by the division or branch in which the report originates.

If, however, no draftsmen are available in that division or branch, an arrangement can be made with any other branch—as the topographic or publication branch—that may have draftsmen available, with the understanding that the cost of the work shall be reimbursed to the branch doing the work by the branch ordering it. For indicating geologic and other data, however, an author may make use of an authentic base map already published, and after it is reduced or enlarged to appropriate scale by photography such a map may suffice for transmittal with a manuscript.

MATERIAL AVAILABLE FOR BASE MAPS.

The maps already published by the Geological Survey[2] and other Government bureaus should always be consulted when a new base is to be compiled. The following list includes most of the maps available:

1. The Survey's regular topographic atlas sheets, published on three scales—15-minute sheets, scale, 1:62,500; 30-minute sheets, scale, 1:125,000; 60-minute sheets, scale, 1:250,000—approximately 1 mile, 2 miles, and 4 miles to 1 inch, respectively—and its "special" maps,[2] some of which are published on other scales. All these maps can be used as bases for detailed geologic maps, for compiling maps on smaller scales, and for revising other maps.

2. The United States part of the international map of the world, now being published on the scale of 1:1,000,000 (approximately 16 miles to 1 inch). Each sheet of this map represents an area measuring 6° of longitude and 4° of latitude. The published sheets of this map may be used as bases for general maps. The sheets are drawn on the scale of 1:500,000, and photolithographs on this scale are available for use as bases for geologic or other maps.

The adaptability of the 1:1,000,000 scale map to use as a base for general geologic maps is shown in the geologic maps of the southern peninsula of Michigan and of Indiana in Monograph 53 (Pls. IV and VII), the map of Florida in Bulletin 60 (Pl. I), and the map of Vermont in Water-Supply Paper 424 (Pl. I).

3. The Survey's two-sheet wall map of the United States, 49 by 76 inches, scale 1:2,500,000 (approximately 40 miles to 1 inch). Parts of this map can be used as bases for general geologic or other maps and as copy for index and other small diagrammatic maps. This map is published both with and without contours.

4. Land Office maps and township plats. These maps are now being published on a scale of 12 miles to 1 inch; they are also photolithographed on one-half that scale, or 24 miles to 1 inch. The town-

[2] See "Topographic maps and folios and geologic folios published by the United States Geological Survey" (latest edition).

ship plats are printed on a scale of one-half mile to 1 inch. The maps are especially useful in compiling maps in which land lines (townships and sections) are essential, and the township plats afford valuable detail and are useful in field work and in revising other maps. Township and section lines should appear on all land-classification maps published by the Survey. On maps on a scale less than 1:250,000 only the townships should be shown; on maps on scales greater than 1:250,000 the sections should be shown; on maps on a scale of 1:250,000 the sections should be shown, unless their representation will materially impair the legibility of the map, in which case only the townships should be shown. (See fig. 1.)

5. Post-route maps, covering single States or groups of adjacent States, published on sheets of different sizes and on scales determined mainly by the size of the State. The map of Texas is published on a scale of 12 miles to 1 inch, that of Virginia on a scale of 7 miles to 1 inch, and that of West Virginia on a scale of 6 miles to 1 inch. Both the Land Office and the post-route maps are useful for reference in compiling maps on smaller scales. Post-route maps are especially useful for comparing and verifying the location of cities, towns, and railroads.

6. Coast and Geodetic Survey charts, published on scales that are governed by the area represented and the amount of detail to be shown. These maps should always be used in compiling and correcting coast lines.

7. Maps and charts published by the Corps of Engineers of the Army, the Mississippi River Commission, the surveys of the Great Lakes, and the boundary surveys. These maps are especially useful if the scale of the map to be compiled requires considerable detail.

8. The Survey's three small base maps of the United States—(*a*) a map 18 by 28 inches, scale 110 miles to 1 inch, which is published both with and without contours, or with relief or hypsometric shading; (*b*) a map 11 by 16 inches, scale 190 miles to 1 inch; (*c*) a map $7\frac{1}{2}$ by 12 inches, scale 260 miles to 1 inch, designed for use as a two-page illustration in a bulletin or a water-supply paper.

9. The Century, Rand McNally & Co.'s, Cram's, Stieler's, The Times, Johnston's Royal, and county atlases.

10. State and county maps.

11. Railroad surveys, which are useful in furnishing data for elevations as well as for locations of towns and stations.

12. The latest national-forest maps and proclamations. It is, however, not necessary that national forests, bird reservations, and national monuments be shown on a map in a report unless their addition is specially requested by the author or by the chief of the branch submitting the report, and they should not be shown if they will obscure other more important data.

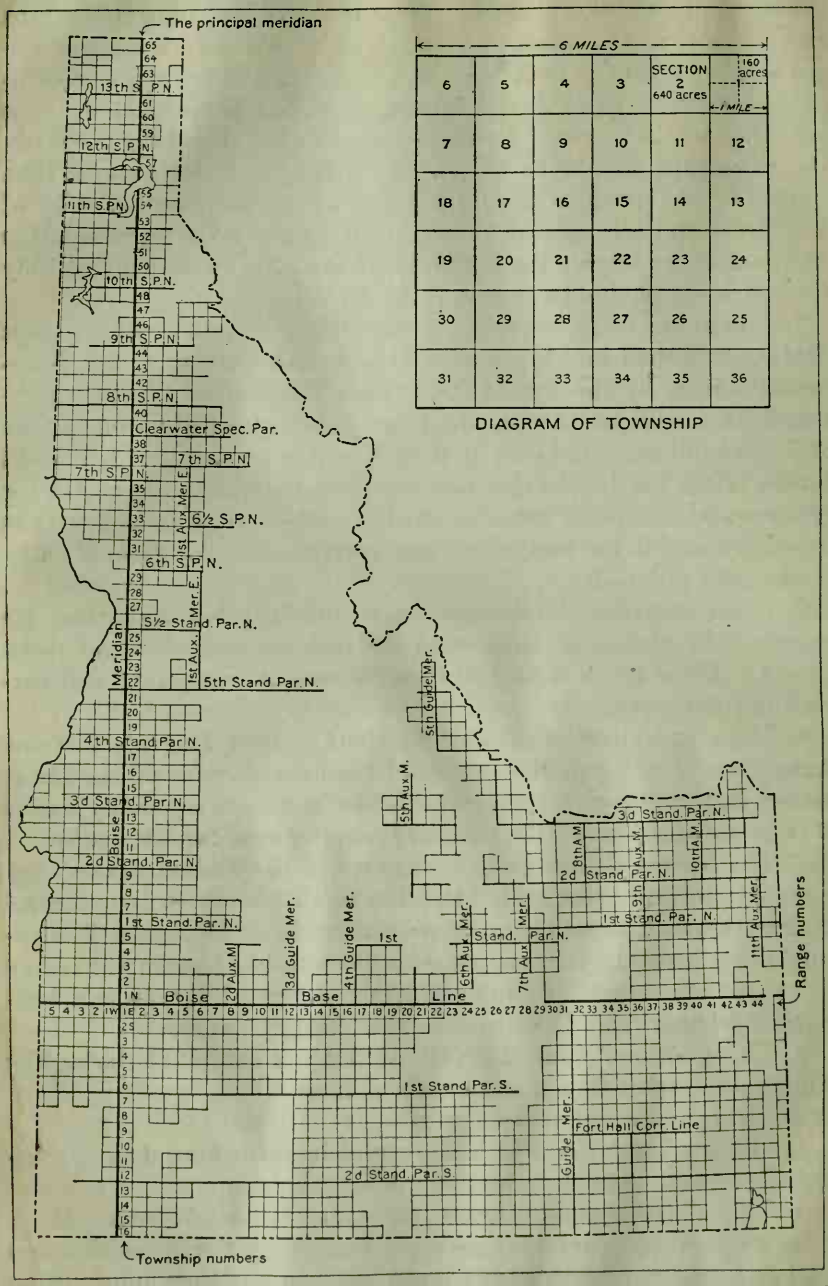


FIGURE 1.—Diagrams showing principal, guide, and auxiliary meridians, standard and special parallels and correction lines, and system of numbering townships, ranges, and sections.

The Survey has published numerous maps of parts of Alaska, as well as other maps, which are available for use or reuse in its reports. Copies of all base maps for which copper plates have been engraved by the Survey can be obtained on requisition, and their use in a new report will save time as well as the cost of engraving. Other maps will be found in the Survey library, where the latest editions only should be consulted.

BASIC FEATURES OF MAPS.

It must be remembered that "every map, whatever its scale, is a reduction from nature and consequently must be more or less generalized."[4] The degree of generalization in the geologic and other detail to be shown on a map usually involves a corresponding degree of generalization in its base. Absolutely true generalization means the same degree of omission of detail for each kind of feature. If a base map on a scale of 1 mile to 1 inch, prepared with the usual detail, were placed before a camera and reduced to a scale of 16 miles to 1 inch, the lines representing the smaller tributaries of streams and the smaller water bodies, as well as many other features, would probably be so greatly reduced in length as to be illegible. If from this reduced photograph a new map were prepared, from which all features not plainly discernible were omitted, the new map should represent what might be called true generalization. This degree of generalization is, however, not practicable, but unessential detail should be systematically omitted. The amount of detail which a base map should show is limited by its scale, by the character of the country it represents, and by the kind of data to be shown. Coordinate features of a topographic map should be shown with equal detail. Detail in culture may call for detail in drainage, though relief may be greatly generalized or entirely omitted; detail in relief may likewise call for detail in drainage, though culture may be more generalized.

If the three fundamental features of a topographic map—the culture, the drainage, and the relief—are to be engraved or photolithographed separately and printed in colors, the best results can be obtained by drawing each feature in a separate color on one sheet unless the work is coarse and great precision in register is not needed. The culture should be drawn in black waterproof ink, the drainage in prussian blue, and the relief in burnt sienna; but care should be taken that the colors used will photograph well. To insure a good photograph it is usually necessary to add a little black to the blue and brown. (See "Inks," p. 25.) The photographer will then make three

[4] Gannett, Henry, A manual of topographic methods: U. S. Geol. Survey Mon. 22, p. 107, 1893.

negatives and will opaque or paint out all but one of the three features on each negative. The cost is somewhat greater than that of reproducing three separate drawings, but the result gives more accurate register than if the drawings were made on separate sheets, which are likely to change in size before they are reproduced.

STANDARD SCALES.

The standard scales of the maps used in the publications of the Geological Survey are fractions or multiples of 1:1,000,000 (see p. 14), except for a map that is reduced expressly to fit one or two pages of a report or that is reduced horizontally or vertically to fit the text as a small diagrammatic or index map. It should be remembered that a map which may be serviceable for use in compiling a new map, except as to scale, can be reduced or enlarged to the scale of the new drawing by photography, by a pantograph, or by other means. (See p. 47.)

Maps compiled by an author should be prepared on a scale of at least 1½ times and preferably twice the size of the scale used on the published map. Maps traced on linen should be no less than twice the size of publication. Not only is the quality of the reproduction improved by considerable reduction, but the larger scale of the drawing facilitates the plotting of details. It should be remembered, however, that a linear reduction of one-half produces a map only one-fourth the area of the original, and reduction so great may prevent the addition of data, such as an extended note in small letters applying to a small area on the face of a map, which would not be legible when reduced.

ORIENTATION OF MAPS.

A map that bears no arrow indicating north is supposed to be oriented north and south, and its title should read from west to east. If, however, the area mapped has a general trend in one direction, as northwest to southeast, and its squaring up by a north-south line would leave too much blank paper, this general rule is not followed. The border lines on such a map should conform to the general trend of the area mapped, an arrow should show north, and the title and scale should be placed horizontally, but the projection numbers and town names should follow the direction of the parallels of latitude. (See Pls. X and XII, Bull. 628; and Pls. VI, XV, and XVI, Mon. 52.)

PROJECTION.[5]

The polyconic projection has been adopted by the Geological Survey for its topographic atlas sheets and must be consistently used

[5] See also pp. 43–45, where the method of projecting a map is more fully explained.

for its other maps. If a new map is to be compiled an accurate projection should first be constructed, and no plotting should be done on it until the projection has been checked and found to be correct. A projection should be checked or proved by some one other than the person who prepared it. Next the drainage and the water areas should be outlined; then the cultural features should be added; and finally the relief, whether expressed by contour lines, hachures, or shading.[6]

EXPLANATION.

Under the heading "Explanation" should be placed all matter needed to describe fully the details of an illustration, whether map, diagram, or section, so that if the illustration became detached it would be a complete self-explanatory unit.

The explanation of a map may be placed inside the border lines if there is ample room for it, or it may be placed outside. The standard arrangement for an outside explanation for geologic maps is shown in the geologic folios, which should be followed in general form. If there is space within the border lines the explanation may be appropriately arranged therein, either in a vertical column or horizontally, according to the size and shape of the space available. If the sequence of formation is shown by horizontal arrangement the younger formations are placed at the left and the older at the right. If it is shown by a vertical arrangement the youngest formation is placed at the top.

Each original map submitted by an author should have at least 4½ inches of blank margin on the right and at the bottom in which to place the explanation, scale, title, and other matter, but the author should make no attempt to elaborate these features nor should he employ a draftsman to letter them carefully. Plainly written ordinary script is quite sufficient for original maps; the final lettering, which may consist entirely of impressions from type, will be added after submittal of a report.

TITLES OF MAPS AND OTHER ILLUSTRATIONS.

The titles of maps should be supplied by authors but are subject to revision in order to make them agree with established forms. They should be written in ordinary script, not carefully lettered. They should state concisely the kind of map, the area shown, the special features represented, and the county, State, or Territory in which the area is located. (See p. 58.) Titles are reproduced directly only on lithographs, three-color prints, photogelatin plates, and other illustrations that are printed by contractors, not by the Government Printing Office. The titles of illustrations that are repro-

[6] See pp. 46–48 for methods of tracing and transferring.

duced by relief processes, such as zinc etching, half tone, and wax engraving, are printed at the Government Printing Office from type, and proofs are submitted to the authors for examination.

SYMBOLS USED ON MAPS.

GENERAL FEATURES.

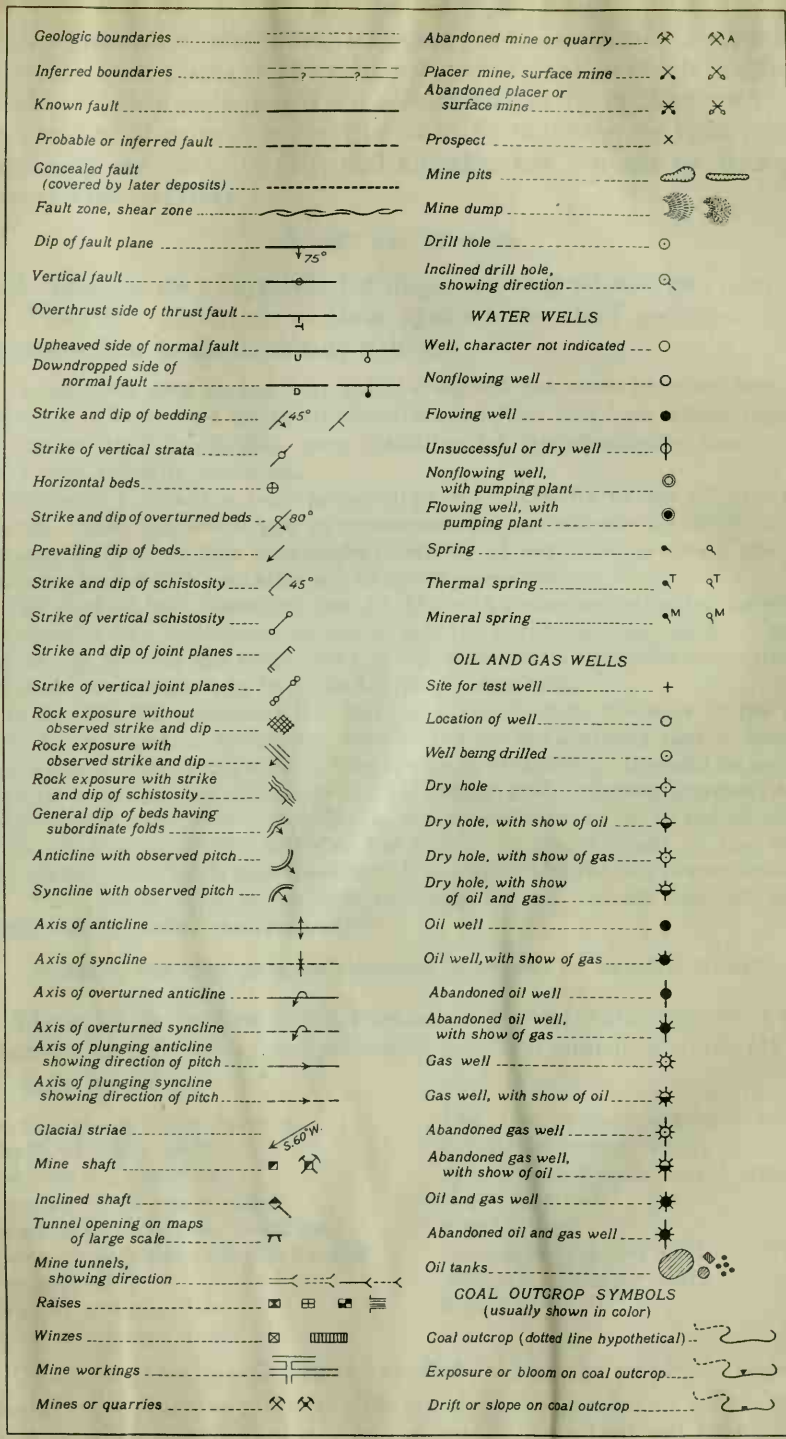
More than 200 symbols have been used on maps to express 25 different kinds of data, a fact indicating at once a notable lack of uniformity and a need of standardization. It is of course impossible to provide a characteristic symbol that can be used uniformly for each kind of feature, and therefore the same symbol may be used on different maps to express different things. The symbols shown in Plate II are those most used on geologic maps. The symbols for dip and strike, fault lines, mine shafts, prospects, and several others are generally well known, but on some maps it may be necessary to modify a standard symbol to express additional distinctions. The symbols shown, however, will cover all the ordinary requirements of miscellaneous mapping. Though the plate shows more than one symbol for some features the symbol most commonly used is given first and should be preferred. The center of each symbol should mark the location of the feature symbolized. Symbols are not always platted with sufficient care. On small-scale maps they are difficult to locate and unless great care is taken in platting them they are likely to be several miles out of place. All symbols should be located precisely where they belong.

The symbol showing dip and strike should be accurately platted by means of a protractor, so that the strike will be shown graphically, without a number and a degree mark, and not need replatting by a draftsman or engraver. The dip, however, should be indicated by a number and a degree mark.

LETTER SYMBOLS.

The letter symbols used on most geologic maps to indicate the ages and names of the formations represented consist of two or more letters—an initial capital letter for the name of the system and one or more lower-case letters for the name of the formation or of the material, as Qt (Quaternary—lower terrace deposits); Cpv (Carboniferous—Pottsville formation); €Ok (Cambrian-Ordovician—Knox dolomite), etc. The standard usage for this feature is shown in the geologic folios but is subject to modification in other publications.

In preparing an original geologic map a letter symbol, such as has been just described, or a number should be put in the proper place



SYMBOLS USED ON GEOLOGIC MAPS, ECONOMIC MAPS, AND MINE PLANS

in the explanation, and the same symbol or number should be repeated at one or more places on the map within the areas to which it refers. Each area that is indicated by a color should be marked with the proper symbol in order to make its identification sure, for light colors especially are likely to fade and mixed colors can not be discriminated with certainty.

OIL AND GAS SYMBOLS.

A complete set of symbols for maps showing oil and gas is given on Plate II. Referring to these symbols the chief geologist, in a memorandum to the Director, writes:

> The symbols used by the Survey in its oil and gas maps have not been in accord with those used by the oil companies, nor have they been wholly logical. It appears that though they were submitted for recommendation they never have been formally approved.
>
> Herewith I submit a code prepared by the geologists of the oil and gas section. They conform largely to commercial use and embrace its best features as well as the best and most logical features of our previous usage, the departures from which are, after all, of minor consequence.
>
> The symbols here submitted [see Pl. II] with recommendation for approval are founded on a building-up system, so that the history and the results of drilling at any location can be recorded by slight additions to symbol and without erasure. Thus maps may be revised without scratching.
>
> In drawing these symbols the draftsman should make the rays of the gas well distinct and in adding the vertical bar or line showing that a hole is dry or abandoned should make it long enough to be distinct. It would be preferable to draw this bar obliquely, but an oblique position would coincide with some of the patterns on certain maps, and it should therefore be placed vertically. The vertical line indicates the failure or abandonment of the well, the symbol for which is thus scratched off or canceled by the line drawn through it. The symbols agree so far with commercial usage that oil men will have little need to consult the explanation.

SYMBOLS FOR USE ON MAPS SHOWING FEATURES OF GROUND WATER.

The symbols used on maps relating to ground water represent the features named below, each of which has been shown in publications already issued.

Area of absorption or outcrop.
Depth to water table.
Contours of water table.
Fluctuation of water table.
Depth to water-bearing formation.
Structure contours of water-bearing formation.
Area of artesian flow.
Head of artesian water.
Area that discharges ground water.
Quality of ground water.
Area irrigated with ground water.
Nonflowing well.
Flowing well.
Unsuccessful or dry well.
Well with pumping plant.
Spring.

The lack of uniformity in the symbols commonly employed to represent these features is due to differences in the number of colors used on the maps and differences in the scale. Standard colors for the

larger features, such as those for areas of artesian flow, areas of absorption, and curves showing depths to water table or to water-bearing formations, can not be fixed, because of considerations of economy in printing. For example, if light green is the standard color to be used for delineating areas irrigated by ground water and no green is used on other parts of the map its use would represent an additional or special printing, whereas a tint of blue, brown, or purple, if any of these colors is used for other features on the map, might be used also for this feature without additional printing. Therefore the general use of any particular color for a water feature seems to be impracticable; but this fact should not preclude the adoption of color standards for use subject to the requirements of economy in publication.

The ordinary symbols for wells are the open circle and the solid circle, or dot. Only in the secondary or specific well symbols does there appear to be lack of uniformity, the choice of secondary symbols being governed either by personal preference or by the requirements for specific distinction.

All symbols should, if possible, suggest the things they represent. Wells are circular and hence the open circle is most used and most appropriate for nonflowing wells. To indicate a flowing well the circle is made solid, denoting that the well is full of water. For an unsuccessful well the most suggestive symbol would be an open circle with a line drawn through it to denote cancellation. It has been suggested that if water features, including wells, are to be printed in blue, unsuccessful wells, or dry holes, be printed in black. A large circle drawn around the symbol for a flowing or nonflowing well will appropriately denote a pumping plant at the well.

The accepted symbol for a spring is a dot with a waved tail representing the direction of flow, if known. This symbol can not be modified without destroying its prime characteristics, but it may be accompanied by a letter indicating the kind of spring. An open circle with a tail might be used on large-scale maps, but it would be out of scale on other maps, whereas the black or blue dot and tail will fit maps of any scale.

The following colors and symbols can most appropriately be used to represent ground-water features. The well and spring symbols can be varied by adding letters if they are necessary to express other data than those indicated in the list below.

General ground-water features.

Area of absorption or outcrop: Flat color used on the map to show the geologic system in which the absorbing formation occurs.

Areas showing depths to water table: Shades of purple and gray; if possible the shades showing the areas of least depth should be darkest and the shades should grade from those to lighter tints.

Contours of water table, or contours on water-bearing formations: Gray or purple curves or lines.

Areas of artesian flow: Blue flat tint, or fine ruling in blue. Depth to water-bearing formations: Gradation of a single color or of two related colors from dark for shallow depths to light for greater depths.

Nonflowing artesian areas (pumped wells): Green flat tint, or fine ruling in green. Depth to water-bearing formations shown by gradation of tint if possible from dark for shallow depths to light for greater depths.

Head of artesian water: Blue curves or lines.

Areas that discharge ground water: Blue flat tint, or fine ruling in blue.

Areas irrigated with ground water: Green flat tint, or fine ruling in green.

- Well, character not indicated.
- Well, nonflowing.
- Well, flowing.
- Well, unsuccessful or dry.
- Well, nonflowing, with pumping plant.
- Well, flowing, with pumping plant.
- Springs.
- T Spring, thermal.
- M Spring, mineral.

The standard color scheme should be used if no conditions preclude its use, but if other colors can be used with greater economy without sacrificing clearness the use of the standard colors should be waived.

BLACK-LINE CONVENTIONS.

A complete set of the black-line patterns used to distinguish areas on a map is given in Plate VIII (p. 60), and their application to a finished drawing is shown in figure 9 (p. 62). These patterns, however, should preferably not be used by the author in his preliminary work on an illustration. For this purpose water colors or colored crayons are preferable, and the distinctions between areas may be emphasized by letter symbols.

MATERIALS USED IN PREPARING MAPS.

PAPER.

For large and important maps which may at some time be extended to cover a greater area or which may be made to fit maps already prepared or published the paper used should be mounted on muslin to reduce to a minimum the shrinking or stretching caused by atmospheric changes. Pure white paper produces a better negative than a cream or yellowish paper and will retain its color longer, but all papers become more yellow with age and exposure to light.

The following brands of paper are used in the Survey in the preparation of maps:

"Normal" K. & E., unmounted. Has an excellent surface and comes in flat sheets, 19 by 24, 22 by 30, and 27 by 40 inches.

"Paragon" K. & E., mounted on muslin. In 10-yard rolls 72 inches wide. Used in the Survey for large office drawings and maps of large scale.

"Anvil" K. & E., mounted on muslin. In 10-yard rolls 42, 62, and 72 inches wide. Used in the Survey for large drawings.

"Whatman's hot pressed," unmounted or mounted on muslin. In sheets ranging in size from 13 by 17 to 31 by 53 inches. An excellent paper for maps. The muslin-backed paper is recommended for use in preparing large detailed maps and base maps that are to be retained as permanent records. The muslin provides a durable and flexible backing that permits the map to be rolled, and paper thus mounted is particularly serviceable for a map which may be subjected to considerable revision and to which must be added finally a title, explanation, and other marginal matter.

"Ross's relief hand-stipple drawing paper." A stiff enameled or chalk-coated paper whose surface has been compressed into minute points that stand in slight relief so that a shade made on it with pencil or crayon is broken up into dots and can be reproduced by photo-engraving. For use in making shaded drawings, drawings showing relief by light and shade, etc. Similar paper is prepared for parallel-line and other pattern effects. In sheets ranging in size from 11 by 14 to 22 by 28 inches. (See p. 51 for method of using.)

Profile and cross-section paper. In sheets of convenient sizes or in rolls. Bears lines printed in blue, green, red, or orange, in many kinds of rulings, which may be selected by reference to catalogues. Profile and cross-section paper printed in orange is recommended for preliminary drawings; blue is recommended for drawings that are made in pencil and submitted for inking in.

BRISTOL BOARD.

For the smaller maps, such as key maps and maps less than 18 by 24 inches, and for small drawings made for direct reproduction, Reynolds's bristol board is recommended on account of its pure-white color and its hardness, which permits erasures to be made without affecting redrawing over the corrected area. It is obtained in 2-ply, 3-ply, and 4-ply sheets. The 2-ply and 3-ply are especially useful in making delicate brush and pencil drawings and pen and ink drawings. The sizes used in the Survey are $16\frac{1}{2}$ by $20\frac{3}{4}$, $18\frac{1}{4}$ by $22\frac{3}{8}$, and $21\frac{1}{2}$ by $28\frac{3}{4}$ inches.

TRACING LINEN.

Tracing cloth or linen is especially useful for large work that will require considerable reduction. (See p. 18.) Its advantages are that a tracing that has been carefully made on it over any kind of copy for direct reproduction by a photo-engraving process can be used for

making a paper negative for contact printing or blue printing. On the other hand, it is susceptible to atmospheric changes that affect scale, and the lines traced on it are not reproduced as sharply as those made on paper. It can be obtained in rolls 30 to 54 inches wide.

Erasures should be made on tracing linen with a hard rubber eraser, not with a sand rubber or a steel eraser.

INKS.

The best drawing inks are in liquid form, ready for use. They should be waterproof and equal to the grade known as Higgins's waterproof ink. When a suitable waterproof blue ink can not be obtained, a good blue for features of drainage can be made by dissolving a half pan of Winsor & Newton's prussian blue in water. No good waterproof burnt sienna ink seems to be obtainable, but a good substitute can be made by dissolving Winsor & Newton's water color of that name.

Ink lines should be drawn in full strength of color—lines that should be black must not appear grayish, for example—and pens should be kept clean. The same pen should not be used for applying two inks, as the mixture thus produced is likely to thicken or coagulate on the pen. A little black should be added to colored inks that are used in making drawings to be reproduced in colors in order to strengthen the lines for photographic reproduction.

DRAWING PENS.

The pens made by Keuffel & Esser, especially their No. 3202, and Gillott's Nos. 291, 290, 170, and 303 give complete satisfaction. The Gillott numbers are given in the order of fineness of the points, No. 291 being the finest. The best cleaner for a drawing pen is a piece of chamois skin.

PENCILS.

Pencils used for drawing should have leads of a quality equal to those of the Koh-i-noor brand, in which the grades of hardness are indicated by 3B, 2B, B, HB, F, H, 2H, 3H, 4H, 5H, 6H, 7H, 8H, and 9H; the softest grade is 3B and the hardest 9H. The grades most generally used are B, HB, F, 4H, and 6H.

RUBBER ERASERS AND CLEANERS.

Two kinds of rubber erasers are usually employed in making erasures on drawings—a hard, dense rubber like the "Ruby," and a soft, pliable rubber like the "Venus" or "H" (Hardtmuth). The soft rubber is also useful for cleaning large surfaces. Art gum is also recommended for this purpose and has the advantage of not disturbing the surface of the paper.

COLORED PENCILS AND CRAYONS.

Colored pencils and crayons are useful only for coloring preliminary maps. They are not recommended for use on maps that are to be kept for reference or to be submitted for reproduction, because the colors rub off, but they can be used on photographic prints of base maps or on transparent oversheets, for which the unglazed side of tracing cloth is well suited. When they are so used register marks should be added at numerous points on the map and the oversheet, including the four corners, the color boundaries should be drawn or traced, and finally the colors should be added. Two or more colors should not be used on any one area to modify a tone, but each area should be colored with a separate crayon. Patterns or designs should not be used except to strengthen contrasts, and for that purpose a pattern may be drawn with a black pencil over a color.

WATER COLORS.

By dilution to half strength some of the standard water colors will yield a tint or hue that will contrast with other tints or hues produced in the same way quite as well as undiluted or full colors will contrast with one another. The colors named below, except chrome-yellow and emerald-green, are among those that when diluted will afford satisfactory contrasts among themselves and with their full colors and are recommended for use in coloring original maps.

Mauve.
Crimson lake.
Orange-vermilion.
Burnt sienna.
Cadmium-yellow.
Chrome-yellow.
Olive-green.
Hooker's green No. 2.
Emerald-green.
Payne's gray.
Lampblack.
Sepia.
Cerulean blue.

Other pigments spread better than cerulean blue and emerald-green, but the exceptional purity of color of these two seems to warrant their use.

JAPANESE TRANSPARENT WATER COLORS.

Japanese transparent water colors, so called, are used by some geologists. They spread evenly and are convenient for field use, but they can not be washed out like other water colors, so that when they are once applied to an area and a change of color becomes necessary they must be bleached out. A good bleach is sodium hypochlorite, which should be applied with a brush until the color disappears, and the area dried with a blotter before recoloring. Light tints of these colors are believed to be somewhat fugitive if exposed to strong light.

COLORING GEOLOGIC MAPS.

The colors used on most original maps are not pleasing, a fact that is of no particular importance, but—and this is of importance—they often fail to give clear distinctions; the separate areas can not always be identified or distinguished with certainty. Again, some colors are fugitive, and when laid on in light tints they disappear entirely or become uncertain. Much of the difficulty in identifying and discriminating colors on an author's original maps is due to the promiscuous mixing of colors. Many persons can not match or discriminate mixed or broken colors. Hence if the supply of a color produced by mixing becomes exhausted and the attempt is made to duplicate it by a second mixture the two will probably fail to match. It is therefore suggested that colors in full strength and colors diluted to half strength be used instead of mixtures of two or more pigments, so that one color in two strengths or tones can be employed to indicate areas that are to be distinguished. The colors listed on page 26 will give 24 satisfactory distinctions and will thus supply all demands for map coloring.

To insure satisfactory contrasts between colored areas on a map, unlike colors should be placed next to each other—that is, colors should be placed together that are widely separated in the spectrum, such as yellow and mauve, red and green, blue and orange, burnt sienna and olive-green; not such as red and orange, blue and purple, orange and yellow, sepia and burnt sienna.

A sufficient quantity of water and color pigment to be used for one formation area on a map should be stirred in a saucer until the desired tint is produced before it is applied. To maintain the same tone properly the color should be well stirred every time the brush is filled; if it is not stirred the brush will on the next dipping take up a lighter tint, because most pigments, especially those derived from minerals, tend to precipitate. When the colors are applied the map should preferably be placed in a slightly inclined position, and the coloring should be started at the upper boundaries of an area to be colored, the well-filled brush being pulled toward the painter and worked rapidly back and forth horizontally, the edges of the fresh color being kept wet. If the edges are allowed to dry, a hard line and a smeared or uneven effect will be produced.

A strong color should generally be used for small areas unless the map shows also large areas that must have the same color; lighter hues should be used for large areas. Bright colors are best suited for areas of igneous rocks, dikes, and veins, and these may be reduced in strength for the larger areas.

The Survey's color scheme (see p. 63) need not be applied at this stage of preparation, except in the most general way. Appropriate

final colors can be best selected when the new map is made ready for engraving. In the author's original maps adequate color distinctions between areas are more important than the use of standard geologic colors. Patterns should not be ruled in one color on an original map to indicate distinctions between different formations of the same age or period, because such patterns are difficult to produce by hand with proper uniformity except by engraving.

It is of vital importance that an original base map should be free from colors and from technical symbols in order that it may be kept clean for photographing and preserved for possible future use. Such a map should preferably be photographed in order to obtain prints on which to add the colors and symbols; the use of an oversheet for this purpose is not nearly so satisfactory. When photographed a base map should be reduced to publication scale in order to save the additional cost of a larger negative, and this reduced map may be made up for publication by the addition of colors and symbols, title, explanation, etc.; but the lithographer will also need the original base map from which to make his reproduction.

DIAGRAMS.

ESSENTIAL FEATURES.

The term "diagrams," as used here, includes such illustrations as mine plans, profiles, sections, stereograms, and maps that are more diagrammatic than cartographic. The first essential in the original drawings for simple diagrams is clearness of copy. Simplicity of subject does not warrant hasty preparation, for an original sketch that has been carelessly drawn and is inaccurate or inconsistent in detail may lead to serious errors. Ruled paper printed especially for platting profiles and cross sections should be used. Curves or graphs made by an author with pencil on blue-lined section paper may be inked by more skillful draftsmen. An author's pencil sketches are usually satisfactory if they indicate plainly the facts to be represented, but they should be prepared with some care as to detail. Tables and like matter are not generally satisfactory material from which to prepare drawings. In drawings for diagrams that are to be printed in the text as figures the use of large, solid black bars or of conspicuous areas of solid black is objectionable, because the black is likely to print gray and to appear uneven in tone. Ruled tints or cross lining give better effects. Stereograms should be prepared by an author with especial care, for they represent facts only as the author sees them, and the author's view must be imparted to the draftsman graphically. The "third dimension"—the relief—in such drawings is not easily expressed and should be brought out clearly in the author's rough sketches.

For illustrations of apparatus photographs are preferred, but if rough sketches are submitted they should show not only correct relations but all dimensions.

PLANS OF MINE WORKINGS.

Blue prints obtained from mining companies are acceptable for plans of mines or underground workings, but all unnecessary or irrelevant details on such plans must be canceled and all essential features retained, and every essential feature, especially any added data, must be clearly interpretable. Many such blue prints are so large and unwieldy that they must be greatly reduced by photography before they can be redrawn. If the lines are too weak to photograph, a tracing of the essential parts can be made and reduced to about twice

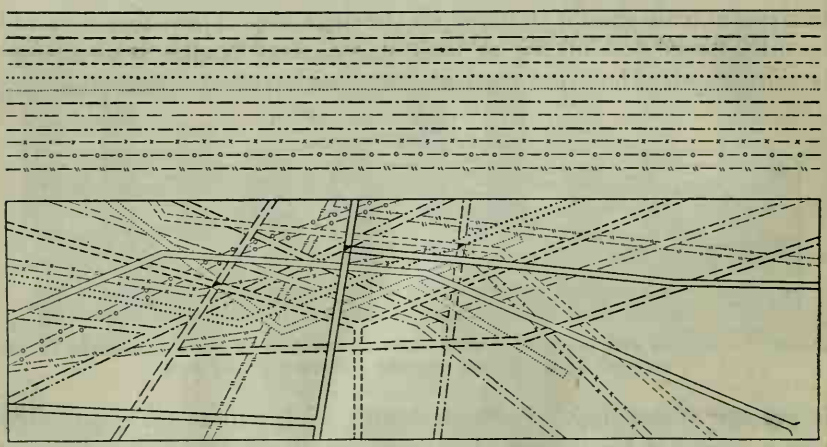


FIGURE 2.—Conventional lines used in preparing plans and diagrams of mine workings to distinguish different levels.

publication size. The shadowless drafting table, described on pages 47–48, is well adapted to the work of making such tracings. Blue prints can also be pantographed to any convenient size if the details are not too minute or complex.

The levels in plans of underground workings can be differentiated in finished drawings by a system of conventional outlines in black, as shown in figure 2, by conventional patterns or symbols within plain outlines, or by colors. Such plans should not be printed in colors unless the maze of workings is so complex that lines showing the different levels would become confused or obscure if printed in black.

SECTIONS.

The standard forms of geologic sections are shown in the geologic folios. Structure sections should be prepared with great care as to

detail but without attempt at refinement of lines and lettering. The author's drawing of a section along a line or zone that is not definitely indicated by a line on an accompanying map should be so prepared that it may be copied exactly. On the other hand, the draftsman, in reproducing a section that represents the structure along a given line or zone, may be able to make the outcrops coincide with the topography and the formation boundaries shown on the map, but the structure, or the interpretation of it to be given, should be carefully worked out by the author. All essential facts relating to bedding, folding, faulting, crosscutting dikes and veins, or other significant details should be indicated with precision. No attempt need be made to draw firm, steady lines so long as the essential facts are clearly expressed.

All sections should be drawn to scale, and both the vertical and the horizontal scale should be given on the drawing. These scales should be uniform if possible, or at least the vertical exaggeration should be minimized. Too great vertical exaggeration creates distortion and

FIGURE 3.—Section and perspective view showing relations of surface features to the different kinds of rock and the structure of the beds.

is grossly misleading. Sections should be drawn to scale on ruled paper prepared for the use of authors. Such paper may be obtained on requisition.

A kind of cross section which is not often used but which gives a more pictorial and clearer conception of underground relations than other kinds is made by adding a sketch of the topography above the section. This sketch should be a perspective view, in which the prominent features shown hypothetically in the section below it will be reflected in the topography. Such a sketch might show, for example, not only monoclinal slopes, "hogbacks" due to steeply upturned beds, terraces, escarpments, and like features, but volcanic necks or other extruded masses in their true relations to the underground geology of the country. (See fig. 3.) In submitting the draft of such an illustration the author should, if possible, submit also a sketch or photographs of the adjacent country and indicate on the section the point of view by notes such as "Sketch A made at this point," "See photograph B." The sketch will be more useful if it is prepared on a scale consistent with the details of the section.

It may be made with a pencil and should show as well as possible the relations of the features in the landscape to those in the section. Some good examples of illustrations of this type can be found in Powell's "Exploration of the Colorado River," pages 182–193. One simpler figure of the same kind is given on the cover of the geologic folios.

In preparing original drawings representing columnar sections, or sections in wells or ravines, the author should indicate all well-defined or important local features of structure, such as cross-bedding, ore bodies, or lenses. If there are no unusual features or details, the subdivisions need be identified only by names of materials, such as "thin-bedded limestone," or "slates with some coal," the coal beds being shown. The sections should, however, be so plotted and subdivided by

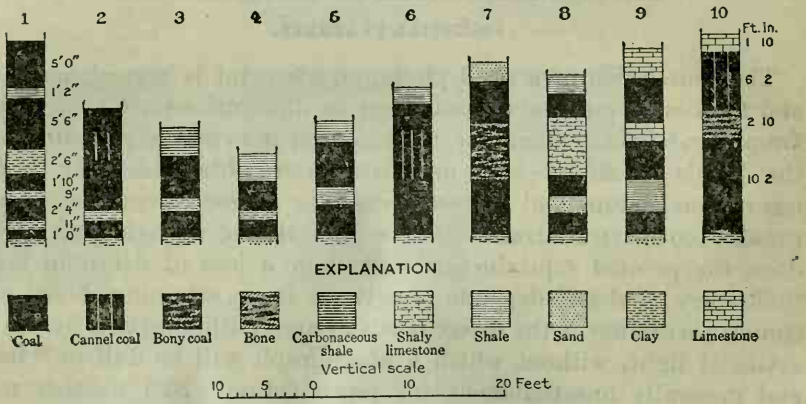


FIGURE 4.—Sections of coal beds. The figure shows the publication size and the arrangement of the sections. Each section should be drawn three-tenths or four-tenths of an inch wide and reduced one-half. Thickness can be indicated by numbers, as shown on sections 1 and 10, or by bar scale.

the author that each section or group of sections will be complete in its crude form. The compilation of various parts into one unit and the construction of columnar sections by reference to tables alone is an essential part of the author's original preparation.

Sections designed to show the relative thickness of beds of coal, arranged in groups for publication either as plates or figures, should be drawn in columns three or four tenths of an inch wide and reduced one-half, as shown in figure 4. These sections, whether correlated or not, should be drawn to some definite vertical scale and should show the thickness of the coal beds, preferably by numbers indicating feet and inches, the other material being symbolized and the symbols explained graphically, as shown in figure 4. The vertical scale should always be stated for the use of the draftsman. A bar scale may be used instead of figures showing the dimensions of the individual beds.

LITHOLOGIC SYMBOLS.

The symbols used to indicate the various kinds of rocks illustrated in sections and diagrams are shown in Plate III. The units or elements of these symbols may be spaced more openly in generalized or diagrammatic sections than in sections that show great detail.

Symbols should be used consistently throughout a report, and in order to make them consistent a set showing the symbol to be used for each kind of rock to be indicated should be prepared before the original drawings are made. Some inconsistencies may be unavoidable on account of the small size of some areas shown and the contrast needed between others; but the deviations from the set of symbols adopted should be minimized.

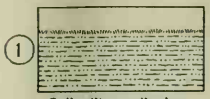
USE OF PHOTOGRAPHS AS ILLUSTRATIONS.

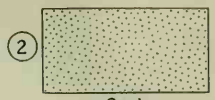
ESSENTIAL FEATURES.

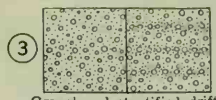
The foundation of a good photographic print is a good negative, and the best prints for reproduction as illustrations are those made from negatives in which the illumination is evenly distributed and the details are sharp—such negatives as are obtainable only by the use of small stops and correct focusing. A good print should not present too sharp contrasts between its dark and its light parts; if it does, the printed reproduction will show a loss of detail in both. Sufficiency of detail depends largely on focus, stopping down, and timing; brilliancy is the direct result of ample illumination by sun or artificial light, without which a photograph will be dull or "flat" and generally unsatisfactory for reproduction. Bad weather may prevent good field exposures, yet even in bad weather acceptable negatives may be obtained by judicious focusing, stopping down, and timing. If a negative is overexposed it may be full of detail, but flat and too thin to print well. If underexposed it will show no details in its lighter parts and the shadows will be black; and a black shadow is nothing less than a blemish. Some detail should appear in all shadows and in the middle tones, and some should appear in the high lights; and a print in which these are evenly developed and in which the illumination is distributed uniformly is technically perfect.

Unfortunately not all field photographs are good, so an author must select from his collection those which will make the best half tones. In making this selection he should of course consider, first, the scientific value of the photograph, and next, its pictorial or artistic quality, which, though of secondary importance, should nevertheless be kept in mind. A feature worthy of illustration deserves good pictorial expression; if it is of superior scientific interest it should not be represented by an inferior photograph. Fortunately, a good,

SUR

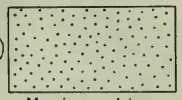

1 Soil, silt, or alluvium

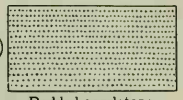

2 Sand

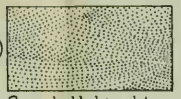

3 Gravel and stratified drift

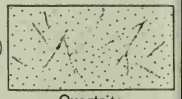
SEDIM

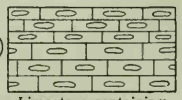
7 Conglomerate

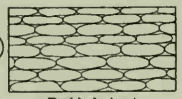

8 Massive sandstone

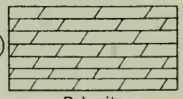

9 Bedded sandstone

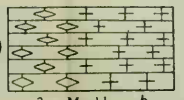

10 Gross-bedded sandstone

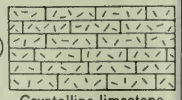

11 Quartzite

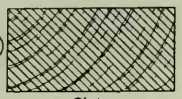

17 Limestone containing nodules of chert or flint

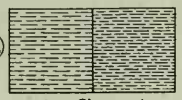

18 Bedded chert

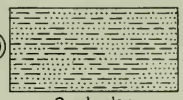

19 Dolomite

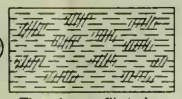

20 a Marble b


21 Grystalline limestone


27 Slate

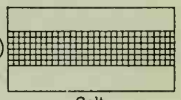

28 a Clay b

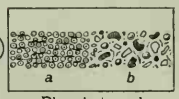

29 Sandy clay


30 Fire clay or flint clay

31 Coal

37 Gypsum

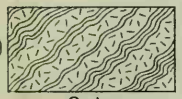

38 Salt


39 a b Phosphate rock

META

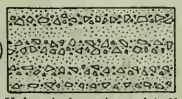
43 Metamorphism
(May be combined with sedimentary and igneous patterns)

44 Schistose or gneissoid granite

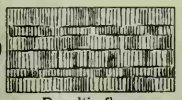

45 Gneiss

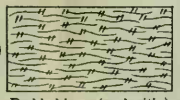
46 Con

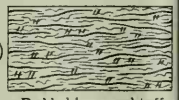
IGNEOUS AN


50 Volcanic breccia and tuff

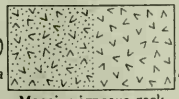
51 Volcanic breccia or agglomerate

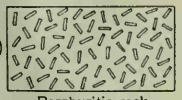

52 Basaltic flows


53 Bedded lava (andesitic)

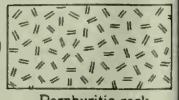

54 Bedded lava and tuff

60 Massive igneous rock


61 a b Massive igneous rock

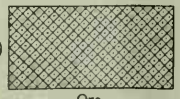

62 Porphyritic rock

63 Porphyritic rock

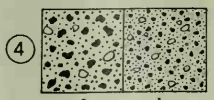

64 Porphyritic rock

70 Quartz

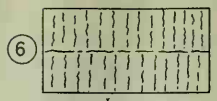
71 Ore
(solid black in thin areas)


72 Ore

FICIAL

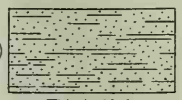


Glacial till and moraines



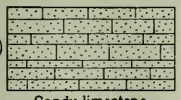
Loess

ENTARY

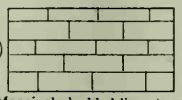


Thin-bedded or shaly sandstone

Calcareous sandstone

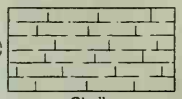


Sandy limestone

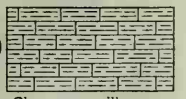


Massively bedded limestone

Thin-bedded limestone

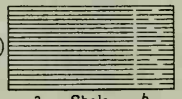


Chalk

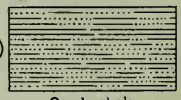


Clayey or argillaceous limestone

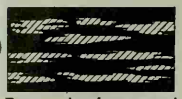
Calcareous shale or shaly limestone



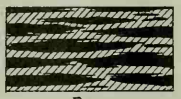
a Shale b



Sandy shale



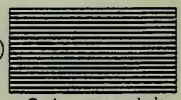
Bony coal or impure coal



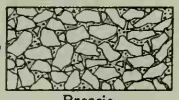
Bone

Gannel coal

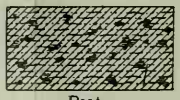
Gannel shale



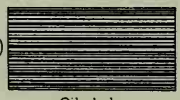
Carbonaceous shale



Breccia

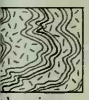


Peat

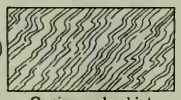


Oil shale

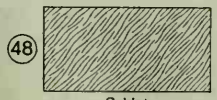
MORPHIC



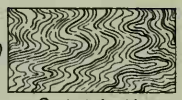
d gneiss



Gneiss and schist



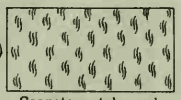
Schist



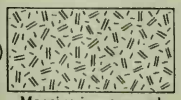
Contorted schist

VEIN MATTER

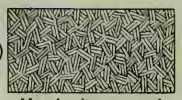
Granite



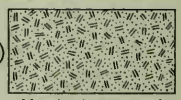
Soapstone, talc, and serpentine



Massive igneous rock



Massive igneous rock



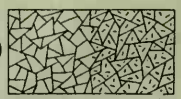
Massive igneous rock

Massive igneous rock

Massive igneous rock

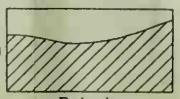
Massive igneous rock

Massive igneous rock



a Brecciated rock b
(sedimentary and igneous)

Lean ore



Bedrock
(kind not indicated)

NAR SECTIONS TO REPRESENT DIFFERENT KINDS OF ROCK

accurate drawing may be made from a poor photograph, and a photographic view that has only minor defects can be successfully retouched. Photographs that need much retouching should generally be larger than publication size, for the effects of retouching—brush marks, etc.—will be softened by reduction. Photographs that need only slight retouching need not be larger than publication size. A photograph can rarely be satisfactorily enlarged in reproduction unless it is sharp in detail and requires no retouching.

Unmounted prints are always preferable for use in making illustrations. A group that is to form a single plate should be placed in an envelope bearing the number of the plate and its title, and each print of the group should bear a corresponding number, written in pencil on its back. The envelope will protect the prints and keep them together, and the numbers will identify them. Red ink should not be used to mark photographs, as it is likely to penetrate the coating or even the fiber of the paper, so that it can not be erased.

If a print is of doubtful quality two copies of it should be submitted—one glazed, the other having a dead finish or "mat" surface, which is generally preferable if the print must be considerably retouched. The best prints for use as illustrations are those made on "regular" or "special" semimat velox and glossy haloid papers. The author should indicate prints that may be grouped together according to their relation geographically or by subject. Generally two half tones will be combined on a page, and the list of illustrations should be prepared accordingly.

With slight trimming and reduction, three photographs measuring 3¼ by 5½ inches may be made up one above the other to form a full-page octavo plate. Four photographs in which the longer dimensions represent vertical distances may sometimes be used if they are placed sidewise on the page, with side titles.

Some photographs may be reduced to the width of a page by trimming instead of by photographic reduction, which may involve loss of detail. The author should clearly indicate the extent of such trimming as they may bear without loss of essential details. The trimming is best done during the final preparation. A line should not be drawn across a photograph to mark such trimming, but the position of the line or lines should be indicated either on temporary mounts, on the backs of the prints, or by a statement, such as "One inch may be cut off on right, one-fourth inch on left, and one-half inch at botto "

COPYRIGHTED PHOTOGRAPHS.

Section 4965 (ch. 3, title 60) of the Revised Statutes, amended by act of March 2, 1895 (Stat. L., vol. 28, p. 965), provides that no copyrighted photograph may be used without the consent of the

proprietor of the copyright in writing signed in the presence of two witnesses. A penalty of $1 is imposed for every sheet on which such a photograph is reproduced without consent, "either printing, printed, copied, published, imported, or exposed for sale." An author should therefore obtain the written consent of the owner of a copyrighted photograph to use it, and the letter giving this consent should be submitted with the illustration.

SOURCES OF PHOTOGRAPHS.

Every photograph submitted with a manuscript should bear a memorandum giving the name of the photographer or the owner of the negative. If the negative is in the Survey's collection that fact should be stated, as "Neg. Keith 318." The Survey receives many requests for copies of photographs that have been reproduced as illustrations in its publications, and replies to these requests will be facilitated if the Survey's number or the source of each photograph presented for use as an illustration is stated as above on the photograph.

LENDING ORIGINAL PHOTOGRAPHS AND DRAWINGS.

A photograph that has been used in making a half-tone cut for a Survey report can not be lent, but if the negative is on file a print can be furnished at cost; and a Survey drawing that is well preserved can be photographed and a print furnished, also at cost. Requests for such prints should be addressed to the Director.

UNPUBLISHED PHOTOGRAPHS.

The Survey can not issue a copy of an unpublished photograph except upon the written approval or requisition of the person under whose name the negative is filed. This requirement does not apply to a print needed for official use, nor to a print made from an old negative reserved under the name of any present member of the Survey or from a negative that has been released by the person under whose name it is filed.

Authors using Survey photographs in unofficial publications are requested to acknowledge the source of the photograph by adding to the printed title such a statement as "Photograph by U. S. Geological Survey (David White)."

SPECIMENS.

GENERAL REQUIREMENTS.

Specimens other than fossils that are to be illustrated in a report should be photographed before they are submitted, but the requisition for the photographs should be initialed by the chief illustrator, who will indicate the kinds of prints needed. Duplicate photographs of the specimens should be made up into temporary plates by the

author and submitted with his other illustrations, the specimens being retained subject to call, if needed, when the illustrations are finally prepared. Should a colored illustration of a specimen be needed, however, the specimen must be submitted with the report, and a different kind of print, preferably one made on platinum or other special paper, will be obtained by the section of illustrations.

BORROWED AND FRAGILE SPECIMENS.

In submitting specimens to be illustrated an author should call attention to those that have been borrowed and to those that are fragile. Borrowed specimens will receive first attention, so that they may be returned promptly.

TRANSMITTAL OF PALEONTOLOGIC SPECIMENS.

All requests for paleontologic illustrations should be addressed to the Director. The letter of transmittal should state the title of the paper, the form of publication desired (bulletin, professional paper, or monograph), and the status of the manuscript, whether completed or in preparation. If the paper is unfinished an estimate of the number of illustrations required should be given, and the special reasons for prompt preparation should be fully stated. A letter transmitting a second or third lot of fossils should refer to the preceding lot or lots if all the fossils are to be used in illustrating the same paper.

Fossils that are to be drawn should be sent directly to the section of illustrations, but those that are to be photographed and require unusual posing or that are extremely delicate and valuable may be sent directly to the photographic laboratory to avoid repeated handling. Each specimen or, if it is very small, each box or bottle containing a specimen should be numbered, and each lot should be accompanied by a list giving their names and numbers. Full instructions as to size of reproduction, together with sketches showing the point of view preferred and any special features to be displayed should also be submitted. All specimens that show strong colors and all groups of specimens that are not uniform in color will be coated by holding them in the vapor of ammonium chloride unless directions to the contrary are given by the author of the paper. As it may not be desirable to apply this process to soft or fragile specimens or to specimens that have been borrowed an author should indicate any specimens that may not be so treated. Specimens whose color aids in revealing detail are not so coated. If any features of a specimen are unusual that fact should be stated so that the photographer and the retoucher may perform their work according to the requirements.

MAKING UP PLATES.

Two or more illustrations may be combined to form one plate in order to permit easy and close comparison as well as for economy, for if a particular illustration is too small to make a full plate and is not suitable for enlargement other illustrations that are closely related to it may be put on the same plate. The size of the printed page as given in the table on page 11 will determine the size of the plate.

In making up plates composed of a number of figures the author should endeavor to group related figures together and at the same time to observe proper regard for artistic effect, but as figures vary in size and shape a grouping according to relations may not be possible in some plates. If related figures can not be kept together the larger and darker figures should be placed in the lower part of the plate and the smaller and lighter above. If a plate consists of one large figure and several smaller ones the large figure should be placed below and the smaller figures above.

A number designating a figure should be placed immediately below the figure, and a series of such numbers should preferably begin with 1 in the upper left corner and continue consecutively across and down through the plate. This arrangement is not always possible, however, on account of variations in the size of figures.

As drawings of fossils or other specimens are prepared separately and grouped into plates, and as most paleontologists make up their own plates, each in his own way, there is naturally great dissimilarity in methods and in results. Ordinary white or light-gray cardboard should be used, and the figures that are to make up a plate should be arranged as stated above but not securely pasted until the grouping is satisfactory. In trimming each drawing or photograph the author should be careful to leave room at its lower edge for the number. Small drawings or photographs, such as paleontologists use, when pasted on bristol board or other board faced with tough paper are difficult or impossible to remove without injury if they have to be remounted; figures pasted on ordinary white or gray cardboard can be removed without difficulty. Each plate should be made up in a size to fit the volume or in its correct proportion to a page in the volume in which it is to be used (see table on p. 11), and each figure should be properly oriented—that is, all vertical lines, or the vertical axis of each specimen, should be parallel with the sides of the plate. When the figures are being mounted care should be taken that the mucilage or paste does not exude under pressure and cover any part of the drawing or photograph. The same attention should be given to pasting on numbers. Inattention to these details may produce results that will affect the reproduction of the plates.

Ordinary mucilage may be used for mounting drawings and photographs, but photo paste gives good results and is perhaps cleaner to handle. Dry-mounting tissue is well adapted to mounting single illustrations but not groups of figures. Liquid rubber is sometimes used, but it is not suitable for mounting small figures, such as drawings and photographs of fossils. It can be used satisfactorily for mounting temporary plates and for mounting photographs in albums and on large cards for study or exhibition; but it has not proved to be a permanent adhesive. Its special merit is that it does not cause either the photograph or the mounting sheet to warp. It is applied by spreading it evenly over the back of the photograph with the fingers. The superfluous rubber can easily be removed from the hands and from the cards or sheets when it is dry. Anything mounted with liquid rubber can be easily removed.

If a plate is to be made up of a small number of figures that require different reductions, the author, instead of mounting or pasting the separate figures on one card in the manner already indicated, may draw a rectangle of the size of the printed plate and sketch within it the several figures in their respective sizes and positions. These "dummy" plates or layouts should be numbered as plates, and they may bear captions and titles. The photographs or drawings represented by the sketches should then be numbered to identify them with the sketches on the dummy plate, and those that pertain to each plate should be inclosed in an envelope attached to the dummy plate. A plate made up in this manner will meet every requirement of the photo-engraver or lithographer.

If a paleontologist so desires, his plates can be permanently made up after he has transmitted his material, but he should always submit a tentative arrangement.

REUSE OF ILLUSTRATIONS.

If an author desires to use in modified form an illustration already published, whether by the Geological Survey or by an outside publisher, he should furnish a print or tracing of the illustration showing the changes desired. If the illustration is not to be modified he need only give the title of the volume in which it was used, with the number of the page, figure, or plate, and he need not make a sketch of the illustration or furnish a dummy; but its title should be quoted and proper reference should be given in the list of illustrations. Due credit should be given to the author or publisher.

The original cuts of illustrations will be kept for one year after the report for which they were made has been published, and authors of later reports may and should reuse, whenever practicable, any such cut that will serve as an illustration. In the author's list of illustrations

such a cut should be referred to by its number as plate or figure and the volume in which it was first used.

An electrotype of any cut on hand will be furnished for use in publications other than those of the Geological Survey at the cost of making, which is 3½ to 5½ cents a square inch of printing surface. The minimum charge for a single electrotype ranges from 45 to 60 cents.

APPROVAL OF FINISHED ILLUSTRATIONS.

After the drawings for a report have been prepared they will be submitted to the author or to the chief of his branch or division for examination. The finished drawings will be accompanied by the "originals," with which the author should carefully and thoroughly compare them. After making a thorough comparison he should mark lightly with a pencil, on the finished drawings, all necessary corrections, or indicate his approval subject to such corrections and additions as may be required. He should verify all type matter and other lettering and assure himself that no mistakes have been made in grouping the photographs into plates, especially such as have been regrouped since they left his hands. The author's list of illustrations will be submitted with the new drawings for this purpose.

REVISION OF ILLUSTRATIONS.

All illustrations receive editorial revision before they are sent to the engravers. After they are drawn they are examined with reference to their scientific features and their accuracy, and then in turn with reference to the correctness of geologic names and geographic names and to errors in statement and in spelling. Each illustration thus, before it is completed, receives critical examination by persons qualified in particular kinds of work to detect errors or omissions.

SUBMITTAL OF PROOFS.

The first proofs of all illustrations are submitted to an author when he is within reach, but if he is in the field and the transmittal of the proofs to him is likely to cause too much delay they are submitted to the chief of the branch or division in which the report was prepared. Second proofs of the more complicated illustrations, particularly geologic maps, may be submitted. An author's examination should be confined principally to the revision of the scientific features of his illustrations, but suggestions as to general effectiveness are always acceptable.

The process to be used in engraving each illustration is stamped in its lower left corner. In examining proofs an author should note the following facts:

1. Changes can not be made in zinc etchings except by eliminating parts, cutting away defects, and connecting lines. If additions are

required reengraving is generally necessary, and reengraving should preferably be avoided.

2. Changes can be made in half-tone plates only by reetching or by tooling parts to make them lighter and by burnishing parts to make them darker. If the proof shows a general loss of detail the fault may lie either in the proving of the cut or in the reproduction. If it is in the reproduction it can not be remedied without reengraving. A slight loss of detail may be expected in all half tones, especially in those that are smaller than the copy submitted.

3. Minor changes can be made in photolithographs and chromolithographs, but changes can not be made twice in one place without danger of affecting the printing. It is customary to approve all lithographic proofs subject to the corrections indicated, the printed edition being examined and compared, but if the changes are numerous and radical second proofs may be required. Second combined proofs of chromolithographs are very expensive. (See p. 89.)

PROOF READING ILLUSTRATIONS.

An author should examine the proofs of his illustrations closely and should compare them carefully with the original drawings. A mere cursory examination may fail to detect errors that have not been caught by the regular proof reader. Every correction desired should be clearly indicated with pen and ink in the body of the proof and inclosed in a loop from which a line should be carried to a marginal note or comment, but if the time available is short a pencil may be used. In correcting type matter or lettering (such as that in a geologic legend or explanation) the ordinary proof reader's marks should be used. The author or the person examining the proofs should initial each one at the place indicated by a rubber stamp.

Proofs should be held only long enough to examine them properly and to compare them with the original illustrations, for a time limit is fixed in each contract for engraving, and if the author holds proofs beyond a reasonable time he causes a delay in the fulfillment of the contract.

As the illustrations for many reports contain important data that will be discussed in the text, proofs of illustrations can not be supplied to any applicant without consent from the Director's office.

GENERAL CONSIDERATIONS.

The following requirements are essential to obtain good original illustrations:

1. The material selected should be pertinent and expressive; it should have the qualities essential to good illustrations.

2. The character of the report and the size of the illustrations should be kept clearly in mind. If the report is preliminary or ephemeral the illustrations should be simple and inexpensive. If the report represents the sum of knowledge on the subject treated or the last word on some particular area the illustrations may be more elaborate. The character of a report generally determines the form of publication, which, in turn, determines the size of the pages and the size of the plates and figures. Every sketch made should be larger than publication size—preferably twice publication size—whether it is a simple diagram or a base map.

3. The kind of reproduction that is apparently needed should be fully considered, for it should have some relation to the kind of report. The illustrations for short-lived reports are reproduced by the cheaper processes. Those for hurried reports are reproduced by processes that can be worked quickly, but no process should be considered that will not give a clear reproduction of essential details.

4. Clearness of preparation of original matter is invariably essential. An author should not expect the draftsmen or the editors to supply missing links. Each original should be complete and should be so made that it can be understood and followed without question. Changes made in the finished drawings or on proof sheets are expensive and delay publication.

PART II. PREPARATION BY DRAFTSMEN.

GENERAL DIRECTIONS.

The work of preparing illustrations such as are used in the reports of the Geological Survey is essentially that of making finished drawings from more or less crude and imperfect material furnished by authors to illustrate certain features or phenomena discussed in their manuscripts. Each finished drawing must be so prepared that it can be reproduced in multiple by one of several processes of engraving. The author's sketches and other material are commonly called "originals"; the finished illustrations are known by the engravers as "copy." Though most engraver's copy consists of more or less elaborate drawings that are to be reproduced in facsimile by "direct" processes without the interposition of handwork, some of it consists of more roughly prepared copy which is accurate in statement but requires complete manual or "indirect" reproduction. The direct processes in use are zinc etching, half-tone engraving, photolithography, three-color half tone, photogravure, and photogelatin. The manual or indirect processes are wax engraving, wood engraving, engraving on copper and on stone, plain lithography, and chromolithography. These processes are described on pages 72–90.

Part I of this pamphlet contains some matter that is pertinent to final preparation and should be consulted by draftsmen.

To prepare a drawing that will be in every way suitable for reproduction usually requires experience of a kind not acquired in many other kinds of drafting, such as preparing engineers' or architects' drawings, because the drawings themselves or blue prints made directly from them are the things the engineer or the architect desires. Drawings prepared for reproduction are generally made larger than publication size, and it is therefore necessary to gage each line, letter, or feature for a definite reduction. Engineers' and architects' drawings generally do not require preparation for reproduction by any process, but in preparing illustrations for the reports of the Geological Survey reproduction must be fully considered at every step, and each drawing must be made according to the requirements of a certain selected process and gaged for a certain reduction. The draftsman should therefore know how to plan each drawing step by step for an engraved cut, a lithograph, a text figure, or a plate, always with a definite result in view. He should be familiar with processes of engraving and should know the special requirements

of each process, and he should be able to prepare drawings for any specified reduction in a way to insure good, legible reproduction.

The geologic draftsman should read and study such textbooks of geology as those of Dana and Geikie and should familiarize himself with structural geology, the geologic time divisions, and geologic nomenclature. He should be able to prepare a simple, effective illustration from complicated rough originals and to supply minor missing essential parts or features. To perform his work successfully he must possess mechanical skill and some artistic taste, as well as good eyesight and great patience.

INSTRUMENTS.

The following list of draftsmen's instruments is practically complete. Those which are considered indispensable are marked by asterisks; the others may be used according to individual preference. The same kind of instrument may be duplicated in different sizes according to the variation in the demands of the work.

Air brush and connections.
Beam compass.
Bow pen, drop spring.
*Bow pen, steel spring.
Bow pencil, steel spring.
*Brushes, red sable.
China saucers.
*Color box.
*Compass, pen and pencil points.
Crayons, assorted colors.
Curve rule, adjustable.
*Dividers, plain.
*Dividers, proportional.
Dividers, steel spring.
Drawing boards, several sizes.
Eraser, glass.
*Eraser, rubber, hard.
*Eraser, rubber, soft.
*Eraser, steel.
Erasing shield.
*French curves, xylonite.
Miscroscope, low power and lenses.
Palette knife.
Pantograph.
Pens, double-pointed.
*Pens, Gillott's, Nos. 170, 290, 291.
Pens, K. & E., drawing, No. 3202.
Pens, Payzant's, 1 set.
*Pencils, best quality, graded leads.
*Protractor.
Railroad curves, pearwood, 1 set.
Railroad pen.
*Railroad pencil.
Reading glass.
*Reducing glass.
*Ruling pen.
Scale, boxwood, 12 inches long, with divisions of millimeters and inches.
Scales, boxwood, triangular.
Section liner (parallel ruling device).
Straightedge, steel, 24 inches.
Straightedge, steel, 36 inches, with divisions for hundredths of an inch and millimeters.
*Straightedge, wood, 24 inches.
Swivel or curve pen.
Thumb tacks.
Tracing point, steel.
*Triangle, 45°.
*Triangle, 60°.
*T square, pearwood, xylonite edge.
*Tweezers, dentist's.

CLASSIFICATION OF MATERIAL.

The draftsman handling the drawings and other original material submitted by the author of a report for its illustration should first group them, as far as possible, into kinds or classes, in order that

he may decide how each illustration should be prepared (1) to express most effectively the author's purpose, (2) to insure reasonable economy in preparation and in reproduction, and (3) to meet the requirements of the processes of reproduction selected. All similar illustrations for one publication should be prepared in the same general style. In a series of geologic sections, for example, the same lithologic symbols should be used throughout for the same kinds of rocks. The titles, explanations, and captions of the maps should also agree with one another in general style and in details of workmanship.

The draftsman should determine in advance the reduction for each drawing or for each group of drawings, in order that he may use the same size of letters or the same kinds of type for the lettering on a series of drawings that require the same reduction. The reduction should preferably be marked in fractions (as "½ off," "¼ off" or "reduce ½," "reduce ¼"), and the choice of the same reduction for a group of drawings will not only insure greater uniformity in the drafting and in the reproduction but will permit the drawings to be reproduced more economically, for the engraver can photograph them in groups instead of each one separately.

The draftsman should therefore note and consider (1) the special features shown in the author's originals; (2) whether or not these features have been plainly indicated and whether the originals are complete; (3) the size of the printed page of the volume in which the illustrations will appear and the reduction required for each drawing; and (4) the process by which each drawing should be reproduced. If an original is of doubtful or uncertain interpretation or appears to be incomplete the draftsman should confer with the author of the paper if he is within reach or should bring the matter to the attention of the chief of the branch; otherwise he may waste much time in making the drawing.

PREPARATION OF MAPS.

PROJECTION.

The base maps furnished by authors (see pp. 13–14) are prepared in many different ways and in different degrees of refinement and of crudity, but the work of redrawing them for reproduction involves well-established and generally uniform principles. All maps except those of very extensive areas should be based on a map projection which will show with a minimum of distortion the effect of the curvature of the earth. The polyconic projection (see fig. 5) is used for most Government maps. In this projection the central meridian is a straight vertical line, and each parallel of latitude is developed independently of the others. The mathematical elements of map projec-

tion are given in tables published by the Geological Survey[7] and the Coast and Geodetic Survey.[8] Figure 5, however, illustrates the mechanical or constructional features of the polyconic projection and if used in connection with the published tables will probably be a sufficient guide for projecting a map on any desired scale.

In projecting a map first select a convenient measuring scale for setting off the dimensions given in the tables, or if no scale is at hand one may be constructed. Measuring scales are made, however, bearing divisions for miles and kilometers and finer subdivisions of 5 to 100 parts. They include the ratios of 1:31,250, 1:31,680, 1:48,000, 1:62,500, 1:63,360, 1:125,000, 1:250,000, 1:500,000, 1:1,000,000, and others. On a map drawn on the scale of 1 to 63,360, for example,

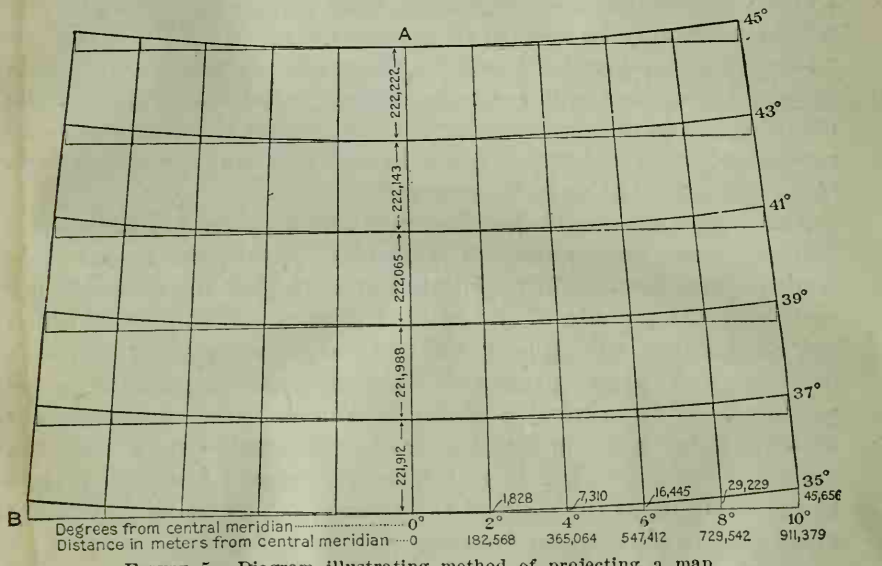


FIGURE 5.—Diagram illustrating method of projecting a map.

1 inch would represent 1 mile; on a map drawn on the scale of 1 to 1,000,000, 1 millimeter would represent 1 kilometer, and so on. It will be seen that the use of a scale that shows in ratios, such as those just given, the actual distance on the ground as compared with the unit representing the same distance on the map will reduce the possibility of error.

The method of projecting a map, illustrated in the accompanying diagram (fig. 5), is as follows: First draw a straight vertical line (A) through the middle of the sheet to represent the central meridian

[7] Gannett, S. S., Geographic tables and formulas, 4th ed.: U. S. Geol. Survey Bull. 650, 1916. See also Gannett, Henry, Manual of topographic methods: U. S. Geol. Survey Bull. 307, pp. 85–86, 1906.

[8] Methods and results: Tables for the projection of maps and polyconic development; Appendix No. 6, Report for 1884; Tables for a polyconic projection of maps, based upon Clarke's reference spheroid of 1886; 3d ed., 1910.

of the map and a line (B) at the lower end of this line exactly at right angles to it to represent the bottom of the map. Then set off on the line showing the central meridian the distances between parallels given in Table 6 on page 36 of "Geographic tables and formulas" (Bull. 650). It should be noted that the figures in these tables give the distance, in meters and statute miles, of 1° on a meridian measured 30′ each way from a point where the meridian is intersected by a parallel. The exact distances between parallels as measured on the ground are given in the Coast and Geodetic Survey tables, or they may be computed from Table 6 of "Geographic tables and formulas" by adding the sum of the figures given for any two latitudes 1° apart and dividing by 2.

The distance between parallels that are 2° apart, as shown in the diagram, may be computed from Table 6 of "Geographic tables and formulas," as follows:

	Meters.	Meters.
1° of latitude on 37th parallel	=100,975.1÷2=	55,487.5
1° of latitude on 36th parallel	=110,956.2	
1° of latitude on 35th parallel	=110,937.6÷2=	55,468.8
True distance from 35° to 37° latitude	=221,912.5	

The distances given in the diagram were obtained by adding the figures given in the Coast and Geodetic Survey tables, which yield the same results. Other tables in Bulletin 650 give the true distances in inches on maps of certain standard scales.

Through the points thus obtained on the central meridian draw lines at right angles to the vertical line. Along these horizontal lines lay off the dimensions in the column headed X, Table 6 (pp. 39–47) of "Geographic tables and formulas" as required for each individual map—in the diagram every alternate degree. Draw vertical lines at these points and set off the distance Y in the same table in a similar manner, and the points so found will be the points of intersection of the respective meridians and parallels. Figures are given on the diagram for the thirty-fifth parallel only.

DETAILS OF BASE MAPS.

Anyone who attempts to draw a base map must, first of all, know how each feature or part of the map should be represented. Most of the conventional symbols for features shown on base maps are well established and should invariably be used; for instance, a line composed of alternate long and short dashes (not dashes and dots) represents a county boundary, and a line or two parallel lines across which short lines are drawn at regular intervals represents a railroad. If he finds that two or more symbols have been widely used to represent

the same feature the draftsman should select the one that is best suited to the map in hand. The correct forms of the conventional symbols or features to be used in preparing miscellaneous maps are shown in Plate IV, but the size and weight of each line or symbol must depend on the size and character of the map.

TRANSFERRING OR COPYING.

TRACING.

The oldest method of transferring a map or parts of a map or other drawing to another sheet is that of copying it by means of tracing paper. This method, though still used for simple work, has given way to quicker and more effective methods. By one of these methods a piece of thin, fairly smooth paper (not necessarily transparent) is coated with graphite by rubbing over it a soft pencil. When the graphite has been evenly distributed over it, this sheet is laid upon the drawing paper, coated side down, the map or other subject to be copied is laid upon the graphite-coated sheet, and the two outer sheets—the drawing paper and the map—are securely fastened together. By a steel tracing point or very hard pencil the lines and other details of the matter to be copied are then firmly and carefully traced and thus transferred to the clean drawing paper beneath.

For maps that show several features in different colors sheets rubbed with blue, orange, brown, or green pencils may be used, one after another, for tracing each set of the features. Red should not be used, as it is not easily erased. This method insures distinctive lines for the separate features and prevents the confusion that might result from the use of one color only. Exact register of the features shown in the several colors used may be insured by fastening one edge of the drawing to be copied to the drawing paper by mucilage or thumb tacks. The colored sheets may then be slipped in and out without altering the position of the lines or symbols for one set of data with relation to those for the others.

In the final preparation of a base map to be engraved and printed in colors—for example, black, blue, and brown—tracings of the three colors appearing on the original base should generally be transferred, as described above, to one sheet of paper and thus worked up into a three-colored map. It is usually unnecessary and undesirable to draw each color on a separate sheet. The preparation of separate drawings may facilitate reproduction, but if they are made on tracing cloth the usual uneven shrinking or stretching of the cloth may produce misregister in the printing; therefore it is safer to make a single drawing, so that the photolithographer can make three negatives and

separate the colors by painting out or "opaquing" the colors not wanted on each negative. A map drawn on a single sheet is also less bulky and can therefore be more conveniently handled and compared with proof.

If for any reason separate tracings for the different colors to be used on a map are considered desirable they should be made on linen cut from one roll and in the same direction according to the warp and woof.

CELLULOID TRANSFERRING.

In the celluloid method of transferring a map or parts of a map to paper upon which a complete new map is to be drawn the map or part of the map to be copied is photographed to the exact scale of the new drawing and reproduced in graphite on thin sheets of celluloid.

The celluloid sheet is then laid face down in the correct position on the drawing paper and firmly rubbed on the back with a steel burnisher, which makes a perfect offset of the map on the paper. After the parts desired are inked over the rest of the graphite print is easily erased with an ordinary rubber.

By using this method it is possible to get absolute scale and more satisfactory results than by tracing over a photographic print line for line or by using a pantograph.

Requisitions for celluloid prints are made on the form used for requesting photolithographic work.

SKETCHING BY RETICULATION.

If the sheet bearing the design or matter to be copied may be marred without objection it is ruled lightly into pencil squares of equal size. Corresponding squares of the same size, larger, or smaller, according to the size of the new drawing, are then ruled on the drawing paper, and the work is sketched square by square. If the original sheet may not be marred the same result can be obtained by drawing the lines on a transparent oversheet. This method is serviceable for enlarging or reducing simple work that includes no great amount of detail; if great precision of detail is required the original should be enlarged or reduced by photography or by the pantograph.

THE "SHADOWLESS DRAFTING TABLE."

One of the most useful contrivances that has been made for tracing a drawing on the same scale is called by its manufacturers the "shadowless drafting table." The essential features of this table are a wooden box inclosing strong incandescent lights and bearing a ground-glass top. A drawing placed on the ground glass can be so

illuminated as to make its lines conspicuous and readily traceable even through relatively thick paper. The table is particularly useful for tracing sheets upon which the lines are indistinct and would not be discernible under tracing paper with reflected light. It is also useful in preparing drawings in which certain features must register perfectly over each other. In fact any drawing that does not require enlarging or reducing can be traced with great facility by the use of this drafting table, and it is particularly useful for tracing faint lines on old and poorly preserved prints or drawings.

Such a table has been installed in the section of illustrations, where it can be used by authors and others.

TOPOGRAPHIC FEATURES.

RELIEF.

The effect of relief is expressed on a map by three methods—by contours, by hachures, and by shading. (See fig. 6.) The first method does not give pronounced pictorial expression of relief, though it gives correct shape and exact elevation; the others are more pictorial, but they do not give exact elevation.

Contours.—As contoured maps are originally prepared from actual surveys the draftsman should simply follow the copy furnished by the topographer or such original matter as may be given to him for redrawing. If the area mapped is large and the contours are close together the original may be transferred by celluloid tracing (see p. 47), or it may be transferred by tracing with graphite-coated paper (see p. 46). After the contour lines have been transferred they should be traced in ink, in lines of even thickness, except those that represent certain fixed intervals and are to be numbered, which should be made slightly thicker. (See fig. 6, A.) In drawing these lines some draftsmen use an ordinary ruling pen, others the swivel pen; but considerable practice is required in the use of either before it can be controlled to follow precisely the penciled lines. Still other draftsmen use the Shepard pen or an ordinary drawing pen. The swivel pen, if expertly handled, produces a firm and even line.

Italic numbers should be used to indicate the elevation of a contour and should be placed in an opening in the line, never between lines. Where the lines run close together great care should be taken that they do not touch unless the interspaces are so narrow that they must touch and combine. The lines should be firm and even, and if the copy or original map shows that they are uniformly very close together it should be enlarged before the tracing is made in order to give more freedom in drawing; but if the enlarged map is to be much reduced care should be taken to make the lines proportionate to the reduction. A photo-engraving of a map on which the contour

lines are drawn very close together is likely to be unsatisfactory because, though the spaces between the lines are reduced in width, the lines themselves may show no corresponding reduction in thickness.

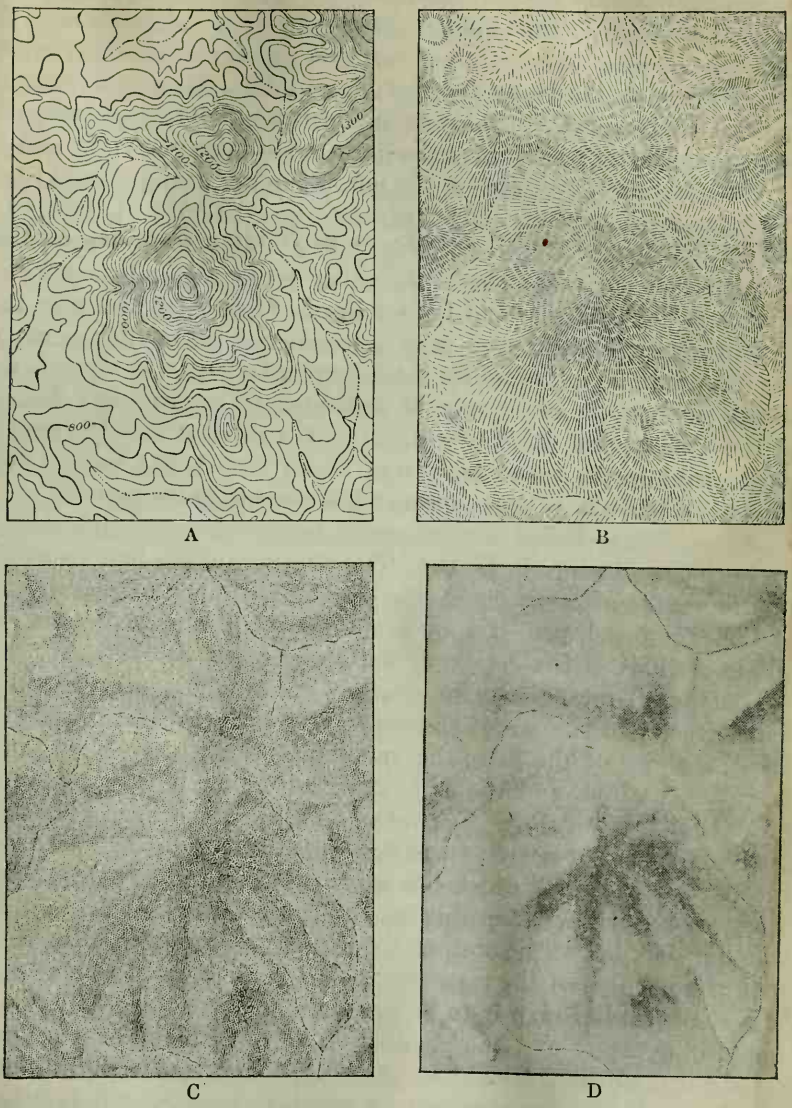


FIGURE 6.—Methods of expressing relief: (A) by contour lines, (B) by hachures, (C) by shading on stipple board, and (D) by a brush drawing. The four examples given represent the same area. The drawings were made twice the size of the printed cuts.

Certain contour lines are commonly accentuated on a map, generally every fourth or fifth line—that is, for a 10-foot interval every 50-foot line, for a 20-foot interval every 100-foot line, for a 25-foot

interval every 100-foot line, for a 50-foot interval every 250-foot line, and for a 100-foot interval every 500-foot line.

Hachuring.—The effect of relief can be produced satisfactorily by hachuring but only by a draftsman who has had considerable well-directed practice in that kind of drawing. In a hachured map the light should seem to come from the west or northwest—that is, the darker parts should be on the east or southeast side of an elevation and the lighter parts on the west or northwest. The highest elevation should be represented by the darkest shade on the right and by a corresponding high light on the left. The hachuring should begin at the crest of a peak, range, or butte and be worked downward toward the gentler slopes, the lines being drawn farther apart and made thinner until the floor of the valley is reached and the effect of shadow is lost by fewer and lighter lines. On a hachured map that is made from a contoured map somewhat definite differences of elevation may be indicated by the intervals between the strokes, and abrupt changes in slope may be indicated by shorter and heavier lines. The strokes should be disjointed, and they should trend at right angles to the upper margin of a cliff and should radiate from a peak. Figure 6, B, represents satisfactory hachuring.

Hill shading.—Relief is more easily expressed by shading than by hachuring. (See fig. 6, C, D.) The draftsman can best express it by this means after he has studied contoured maps or photographs of the region mapped, if they are available, in order that he may obtain an idea of the details of its topography.

The special means used to produce hill shading will depend on the character of surface of the paper on which the drawing is to be made, the size of the map, the amount of detail and refinement of execution desired, and the amount of reduction to be made in reproducing the drawing. For maps on which it is desired to show some refinement of drawing and detail, a lithographic or wax crayon can be used on paper which has a grained surface. The draftsman must express relief according to the information he has at hand, whether detailed or general, and must employ methods that accord with the purpose of the map and the mode of reproduction selected. If a shaded relief map is to be prepared for direct reproduction by photolithography and the shading is to be printed in a separate color the base map should be completed first and a light photographic or blue print obtained on which to add the relief in black lithographic crayon, to insure perfect fitting of the relief and the base; or the relief can be prepared on an oversheet—a semitransparent white paper with sufficient "tooth" or grain to cut the shading up into minute dots. The shadowless drafting table (see p. 47) is especially useful for this purpose. On this oversheet register

marks should be placed at the four corners and at several other points, particularly at the intersection of parallels and meridians.

For relief shading on small black and white maps Ross's hand-stipple drawing paper may be used. (See p. 24.) By rubbing a black wax crayon or pencil over the surface of the paper the desired effect is produced in fine dots or in stipple, which may be varied in density of shade at the will of the draftsman. (See fig. 6, C.) High lights can be produced by scraping away the chalky surface of the paper. A lithographic or wax crayon is the best medium to use on this stipple paper, as on the paper referred to in the preceding paragraph, for the shading produced by it is not so easily smeared as that produced in pastel or by a graphite pencil. The object of using either the rough paper or Ross's stipple paper for drawings that are to be reproduced by photo-engraving is to produce a shading that is broken up into dots of varying sizes, which is essential in such reproduction.

Relief shading for maps can also be made with a brush in flat washes of either india ink or lampblack. Such shading should be made only over a blue print or an impression of some kind from the map upon which the shading or relief is to be overprinted. If the relief is expressed on the author's original by contours the general shapes of the relief and the drainage lines can be traced and transferred lightly in blue lines to form a base on which to model the shading and at the same time to make the shading fit the streams. Such a drawing can be photographed through a screen and reproduced by half tone (see fig. 6, D) or mezzotint as a separate plate made to overprint the map in another color.

HYDROGRAPHY.

General directions.—The drainage features of a map should be so drawn as to suggest the natural courses of the streams. Streams should not be drawn in straight, hard lines, as such lines are decidedly unnatural and produce a crude effect. The course of a river may be straight in general, but it is likely to be somewhat sinuous in detail. If the streams shown on a preliminary map are drawn in a clumsy or characterless fashion they should be redrawn with a freehand effect or made slightly wavy, in order that they may appear more natural. The gradual widening of streams from source to mouth should also be shown in the drawing. On small-scale maps, where the eye can at once see a stream through its full length, this almost imperceptible widening can be expressed by a line of almost uniform weight except for the stretch near the source, where it should grow thinner and taper off. On maps which are to be reproduced directly from drawings in black and white and which are to show

both contour lines and drainage the lines representing the streams and other water bodies should generally be drawn freehand and slightly heavier than the contour lines, which should be sharper and more precise.

The names of all streams or other bodies of water should be in italic letters, those of the larger streams being lettered in capitals and those of the smaller streams in capitals and lower-case letters. (See "Lettering," p. 53.)

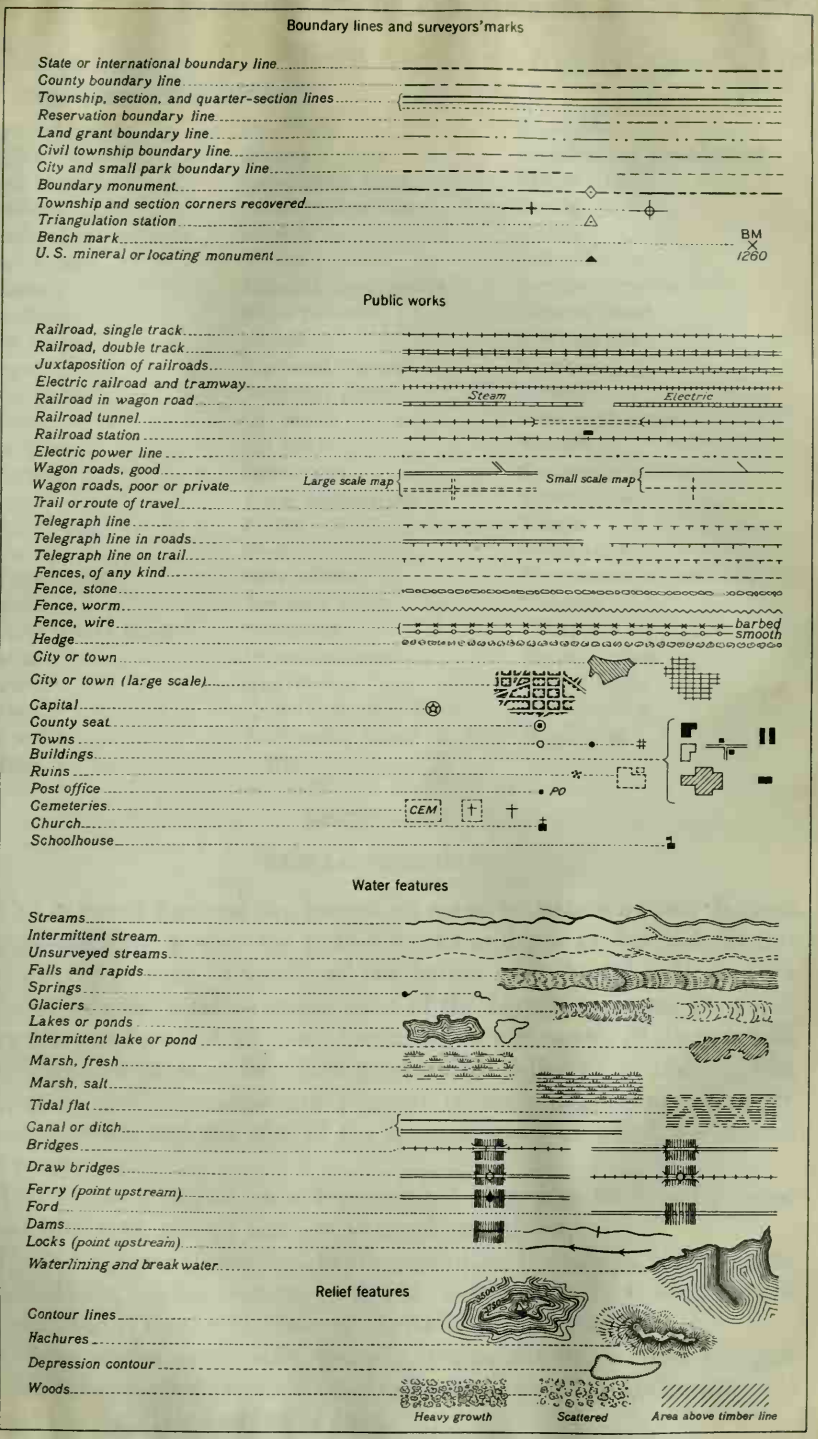
Water lining.—The use of water lining on black and white maps should be limited to maps on which the water areas are not readily distinguishable from the land areas. In rough drawings that are to serve only as copy for engravers a flat color may be used for water areas and its conversion into water lines specified. In base maps to be reproduced in three colors a light-blue tint may be used in lieu of water lining, and it can be printed either flat or in a fine ruling transferred to the stone that is to print the drainage. The engraving of water lines is expensive, and the flat blue color should generally be preferred.

Water lining usually consists of 30 to 45 lines on engraved or large maps, but on small maps and sketch maps the number may be reduced as desired. Care should be taken that the lines are as nearly parallel as they can be made freehand and of even weight or thickness. The first three to six lines outside the coast line should be somewhat closer together than those farther out and should conform closely to the coast line, but the spacing between the lines should increase and the lines should become almost imperceptibly less conformable to the coast line as they reach their outer limit, the last three to six being made with the greatest care and refinement. Water-lined maps that are to be reproduced by photographic processes should be drawn at least twice publication size. The reduction will bring the lines closer together, and the reproduction will show a more refined effect than could possibly be produced by the most skillful drawing.

Good examples of water lining, such as are shown on the topographic atlas sheets of the Survey, should be studied by draftsmen before they undertake such work.

CULTURAL FEATURES.

The cultural features represented on a map include "the works of man"— not only cities, towns, buildings, bridges, railroads, and other roads, but State, county, and other boundary lines—in short, all that part of a three-color base map which is shown in black, the engraved plate for the black being called the culture plate. The features named



SYMBOLS USED ON BASE MAPS

in the list below are the cultural features referred to. (See Pl. IV for corresponding symbols.)

Aqueduct mains.
Aqueduct tunnels.
Bench marks.
Boundary lines.
Boundary monuments.
Breakwaters.
Bridges.
Buildings.
Cable lines.
Camps.
Canal locks.
Canals.
Cemeteries.
Churches.
Cities.
County lines.
Dams.
District lines.
Ditches.
Electric power lines.
Fences.
Ferries.
Fords.
Gas wells.
Hedges.
Hospitals.
Jetties.
Land-grant lines.
Land-section lines.
Levees.
Mains.
Mineral monuments.
Mine tunnels.
Mines.
National forests.
National parks.
Oil tanks.
Oil wells.
Open cuts.
Park boundaries.
Paths.
Pits.
Post offices.
Precinct lines.
Prospects.
Province lines.
Quarries.
Quarter-section lines.
Railroads, steam or electric.
Ranches.
Reservation boundaries.
Reservoirs.
Roads.
Ruins.
Schoolhouses.
Section corners.
Section lines.
Settlements.
Shafts.
Streets.
Telegraph lines.
Towns.
Township corners.
Townships.
Trails.
Tramways.
Triangulation stations.
Tunnels.
Villages.
Water mains.
Water wells.
Waterworks.
Windmills.

LETTERING.

GENERAL DIRECTIONS.

The cultural features are named on maps by letters of two distinct styles—slanting gothic for public works and roman for habitations and civil divisions. The size of the letters used should indicate in a general way the relative importance of the feature or group to which they are applied, but on some maps the county seats, State capitals, and large cities may be distinguished by different symbols. The names of civil divisions are lettered in sizes depending on their relative grade and the size of the area or space in which the names are to appear.

The features shown on a topographic map may be broadly separated into four groups and are lettered as follows:

Civil divisions (countries, States, counties, townships, land grants, reservations, cities, towns, villages, settlements, schools, lodges, ranches, etc.), roman capitals or capitals and lower case.

Public works (railroads, tunnels, roads, canals, ferries, bridges, fords, dams, mains, mines, forts, trails, etc.), slanting gothic capitals (light) or capitals and lower case.

Hydrographic features (oceans, seas, gulfs, bays, lakes, ponds, rivers, creeks, brooks, springs, wells, falls, rapids, marshes, glaciers, etc.), italic capitals or capitals and lower case.

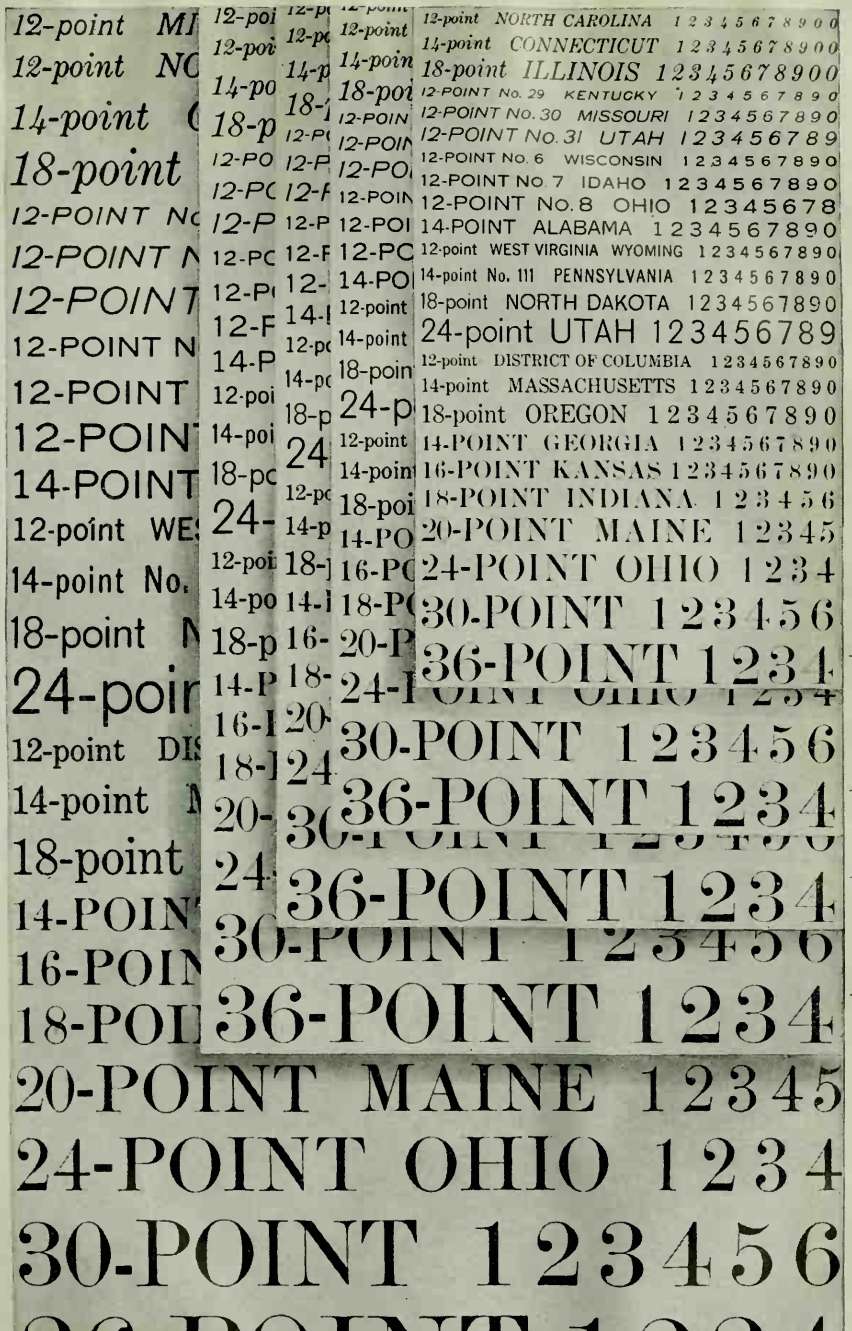
Hypsographic features (mountains, ranges, peaks, plateaus, cliffs, buttes, canyons, valleys, peninsulas, islands, capes, etc.), upright gothic capitals (light) or capitals and lower case.

The essential principles of lettering have been described in numerous treatises and are well understood by most draftsmen. The correct form of each letter may be learned from such treatises, but spacing and arrangement are best learned by observation and experience. Good lettering will not strongly attract attention, but even slight imperfections of form, spacing, slant, and shading will be quickly detected and criticized. Map letterers should note that the name of a place or the number of a symbol should be put to the right of the symbol if possible and a little above or below it—not to the left and directly on a line with it, as Tucsono, 17o, Dallaso, Carsono. Names indicating large areas, if written from west to east, should curve with the parallels, and all names should be so lettered that "if they should fall they would fall on their feet." Every name should be distinctly legible but not so conspicuous as to subordinate the feature it designates. Lines should therefore not be broken in order to make the lettering clear except where there is possible danger that the smaller spaces may be filled up in printing. The lettering on a map should always be so spaced that it will properly fit the area it is intended to designate. In names consisting of two or more words the letters should not be closely spaced if wide spaces are left between the words. In numbers, except those used to indicate elevations on contour lines or elsewhere, thousands should always be set off by commas.

Draftsmen often draw bad forms for commas, quotation marks, apostrophes, and question marks. The following forms are correct: Comma , ; quotation marks " " ; apostrophe ' ; question mark ?.

LETTERING BY TYPE.

Names and short notes printed from type on paper, to be cut out and pasted in proper positions on maps or other drawings, now furnish a large proportion of the lettering on the Survey's illustrations. The strips are likely to become detached by the repeated handling of a drawing, however, unless they are securely pasted on. The best results can be obtained by having the type printed on a special brand of "noncurling" gummed paper, from which the lettering is cut in squares or strips, which are dampened and applied to the proper places on the drawing. In handling such strips a pair of dentist's tweezers is useful. When mucilage is applied to printed strips of ordinary paper the moisture causes the paper to warp or curl, often so much as to affect the reproduction of the drawing. This printed



REDUCTION SHEET USED IN LETTERING ILLUSTRATIONS.

The largest size shows the letters unreduced; the other sizes show the letters reduced as indicated in the margin.

lettering is generally used, however, only for headings, titles, notes, and other matter that stands alone; it should not be used for the geographic names in the body of a map unless only a few names are to appear, for the strips of paper bearing the names may obscure parts of the map. The reproduction of this lettering by photo-engraving or photolithography gives results superior to those obtained from hand lettering unless each letter is made with the utmost care, work which is considered a waste of time.

Type is used also for printing lettering directly on a drawing exactly in proper position, by a special type holder, somewhat like a self-inking stamp.

Most of the styles and sizes of type now used on maps in the Survey's reports are shown in Plate V.

If a drawing is to be reduced one-half the smallest type used should be about 2 millimeters in height; if it is to be reduced one-third the smallest type used should be about 1.5 millimeters in height; and so on. No letter whose vertical height after reproduction would be less than about 1 millimeter should be used, and the larger lettering should bear a proper relation to the smaller. Sheets showing the styles of type in use by the Survey, in full size and reduced one-fourth, one-third, two-fifths, one-half, three-fifths, two-thirds, and three-fourths, will be furnished on request. If a drawing is to be reduced one-half, for example, the sheet that has been reduced one-half will show the size of the lettering on the printed plate, so that the draftsman, by referring to the sheet showing the reduction he desires, can select type of a size that will be legible. Plate V shows a part of this reduction sheet.

ABBREVIATIONS.

The following are the correct forms for abbreviations used on maps and other illustrations:

A.	Arroyo.	Is.	Islands.	Pk.	Peak.
B. M.	Bench mark.	Jc.	Junction.	P. O.	Post office.
Bdy.	Boundary.	L.	Lake.	Pt.	Point.
Br.	Branch, bridge.	Lat.	Latitude.	R.	Range, river.
C.	Cape.	Ldg.	Landing.	Res.	Reservation, reservoir.
Can.	Canal, canyon.	L. S. S.	Life-saving station.	R. H.	Road house.
Cem.	Cemetery.			S.	South.
Co.	County.	L. H.	Lighthouse.	Sd.	Sound.
Cr.	Creek.	Long.	Longitude.	S. H.	Schoolhouse.
E.	East.	M. P.	Milepost.	Sta.	Station.
El.	Elevation.	M. M.	Mineral monument.	Str.	Stream.
Est.	Estuary.			T.	Township.
Fk.	Fork.	Mt.	Mount.	Tel.	Telegraph.
Ft.	Fort, foot.	Mtn.	Mountain.	W.	West.
Gl.	Gulch, glacier.	Mts.	Mountains.		
Hbr.	Harbor.	N.	North.		
I.	Island.	Pen.	Peninsula.		

Words like mount, river, point should not be abbreviated where they form a part of the name of a city or town, as Rocky Mount, Fall River, West Point. Neither the word nor the abbreviation for railroad or railway should be placed on a map; the chartered name (or initials of the name) and the road symbol are sufficient.

Names of States and Territories should be abbreviated, where abbreviation is necessary, as follows:

Ala.	Ga.	Minn.	N. J.	Tenn.
Ariz.	Ill.	Miss.	N. Mex.	Tex.
Ark.	Ind.	Mo.	N. Y.	Va.
Calif.	Kans.	Mont.	Okla.	Vt.
Colo.	Ky.	Nebr.	Oreg.	Wash.
Conn.	La.	Nev.	Pa.	W. Va.
D. C.	Mass.	N. C.	R. I.	Wis.
Del.	Md.	N. Dak.	S. C.	Wyo.
Fla.	Mich.	N. H.	S. Dak.	

Alaska, Guam, Hawaii, Idaho, Iowa, Maine, Ohio, Samoa, and Utah should be written in full.

The abbreviations used on the margins of maps for subdivisions of land should be as follows (note punctuation): T. 2 N., R. 3 W. On large-scale plats the marginal lettering should be as follows: N. ½ NE. ¼ sec. 1, T. 7 N., R. 2 W.; fractional secs. 2 and 35, Tps. 7 and 8 N., R. 2 W.; NW. ¼ sec. 20, T. 7 N., R. 2 W. In spelling fractions use half and quarter, not one-half and one-quarter.

The abbreviated forms of such names as North Fork and South Fork should be N. Fork and S. Fork, not North Fk. and South Fk.

Additional abbreviations used on illustrations are as follows:

N. for north, NE. for northeast, NNE. for north-northeast, etc. Capitalize directions affixed to street names, as NW., SE. (1800 F St. NW.).

Sec. and secs. for section and sections before a number. Capitalize only at the beginning of a line or sentence.

a. m. and p. m. for antemeridian and postmeridian, as 4.30 p. m. Lowercase unless in line of caps.

& in names of corporations or companies. On Survey miscellaneous maps "and" is spelled out in railroad names.

B. t. u. for British thermal units.

bbl., bbls. for barrel, barrels.

bu. for bushel or bushels.

c. c. for cubic centimeter.

cm. for centimeter.

cwt. for hundredweight.

dwt. or pwt. for pennyweight.

oz. for ounce or ounces.

etc. (not &c.) for et cetera.

ft. for foot or feet.

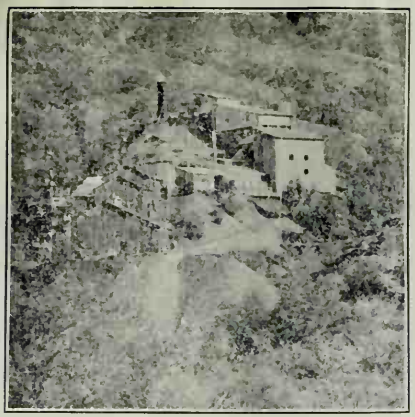
H. m. s. for hours, minutes, and seconds. (Use capital H.)

in. for inch or inches.

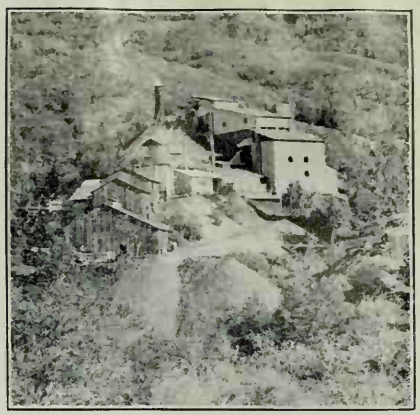
kw. for kilowatt or kilowatts.

£ s. d. for pounds, shillings, and pence.

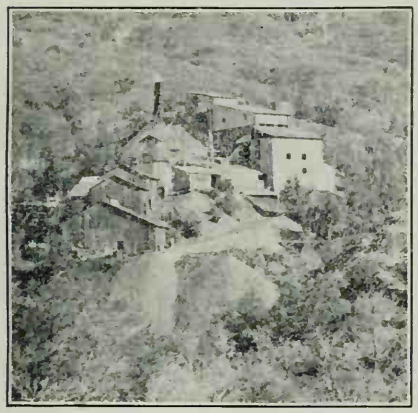
per cent (omitting period) for per centum. Spell out percentage.



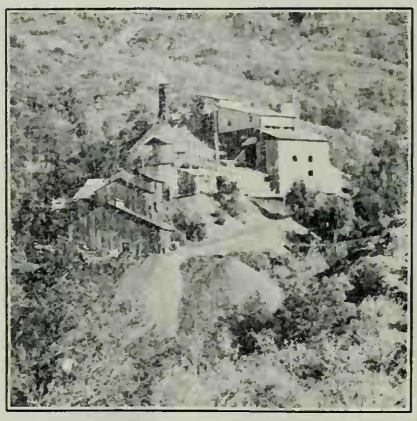
175-LINE SCREEN.



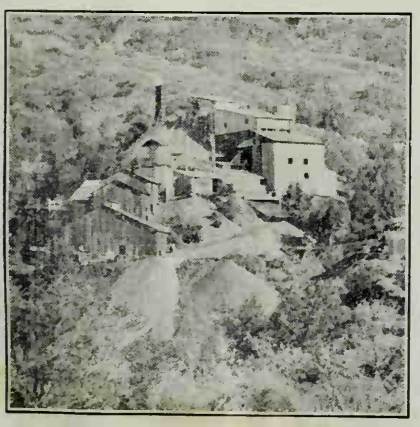
150-LINE SCREEN.



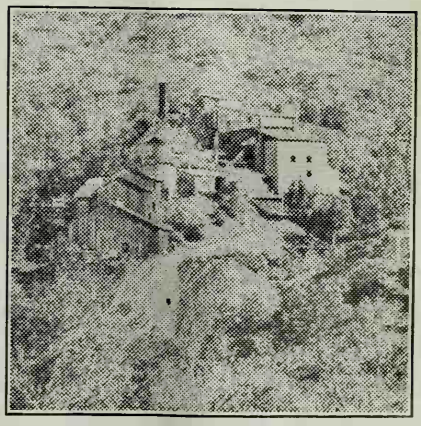
133-LINE SCREEN.



120-LINE SCREEN.



100-LINE SCREEN.



65-LINE SCREEN.

HALF-TONE CUTS SHOWING EFFECT OF SEVERAL STANDARD SCREENS IN THE REPRODUCTION OF THE SAME DETAIL.

ser. for series.

St. for Saint or street.

U. S. Army for United States Army, as distinguished from United States of America (U. S. A.).

yd., yds. for yard, yards.

The names of certain months may in some places be abbreviated; those of others should invariably be spelled out. The following are the correct forms:

Jan.	Apr.	July	Oct.
Feb.	May	Aug.	Nov.
Mar.	June	Sept.	Dec.

The abbreviations for number and numbers before figures are No. and Nos. The o should never be raised, as in N°. The abbreviation for Mac is Mc, not Mᶜ.

All periods should be omitted from abbreviations used in the body of a map unless their omission would cause misunderstanding. They are generally unnecessary, and if used on some maps they are likely to be mistaken for symbols representing certain features, such as houses or flowing wells, if either are shown. Periods used on drawings that are to be reproduced "direct" or photomechanically should always be slightly exaggerated.

NAMES OF RAILROADS.

The names of railroads may be written in full or abbreviated, in accordance with the kind of map and the space available. On a sketch map in black and white the initial letters are generally sufficient. On a more detailed map, if there is room enough, the names may be spelled out. As already stated, neither the words "railroad" and "railway" nor the abbreviations R. R. and Ry. should be used on a map.

MAKE-UP OF MAPS.

FORMS FOR CERTAIN FEATURES.

The proper forms for certain features of maps, such as the borders, titles, explanations, bar scales, captions, arrows indicating true north and magnetic declination, source, and authorship, are shown in Plate VII. Note particularly the style and position of the marginal matter.

BORDER.

A finished map border is used or omitted according to the kind of map prepared. Diagrammatic maps and maps on which no parallels and meridians appear do not need finished borders. On a map that shows complete areal geologic or other coloring, such as a map in a Survey geologic folio, the border lines tend to destroy the simple effect of the whole map. On a map that is not completely colored and on all very large maps borders are really necessary. If borders

are used, however, the space between the neat line and the outer line of the border should be only sufficient to provide proper space for the numbers showing latitude and longitude or township and range. A simple rule[9] for determining the width of this space is as follows: Divide the sum of the dimensions of the map by 2 and find the square root of the quotient, which will represent the width of the border in sixteenths of an inch. Example: Map is 20 by 30 inches; $\frac{20+30}{2}=25$; square root of $25=5$; width of border $=\frac{5}{16}$ inch.

The numbers showing latitude and longitude should be in shaded arabic numerals and those showing township and range in gothic. The symbols for degree, minute, and second should not be crowded. On a map that has no added border lines the numbers should be in hair-line gothic.

TITLE.

The title of a map should be in roman letters and if placed at the lower margin should generally be arranged in two lines, unless it is short. If it forms two or more lines the lines should be well balanced. The first line should describe the position of the area; the second line should state the purpose of the map, as

MAP OF BUTTE AND VICINITY, MONTANA
SHOWING LOCATION OF MINES AND PROSPECTS.

A title placed inside the border of a map should be arranged in a series of lines, generally beginning with "Map of" or "Geologic map of," and the line showing the dominant part of the title should be emphasized by larger lettering, thus:

MAP OF
THE VICINITY OF BUTTE
MONTANA
SHOWING LOCATION OF MINES AND PROSPECTS.

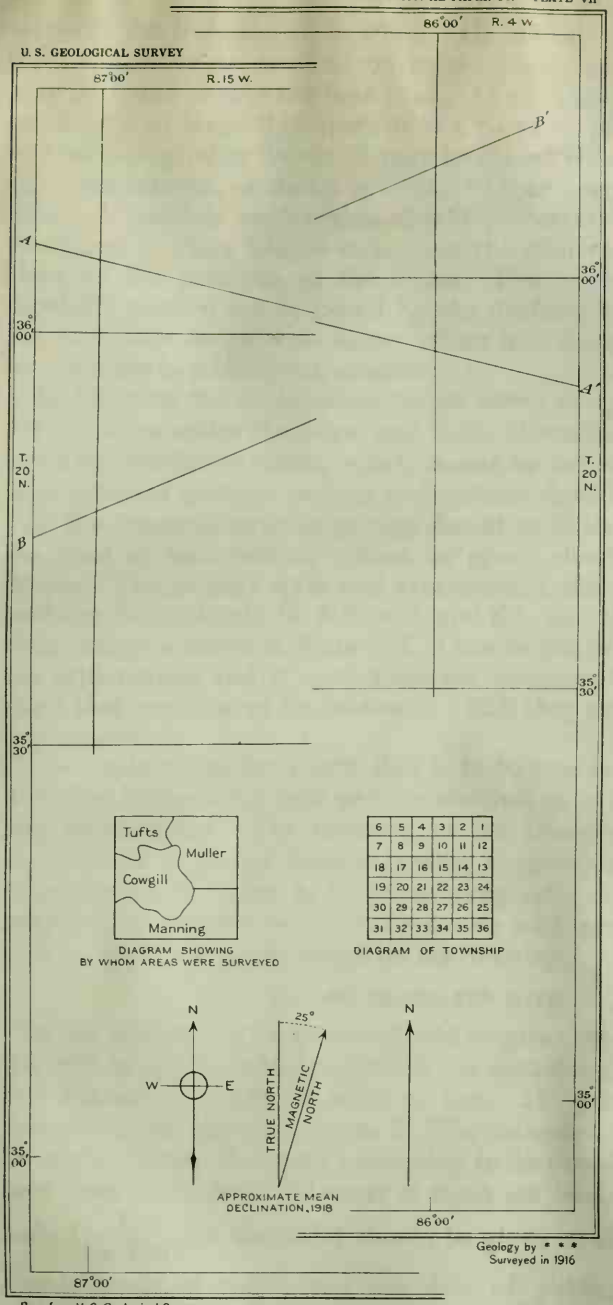
The name of the author or compiler of a map or of the person supplying the geologic or other data shown on it may be placed either beneath the title or in the lower right corner, just below the border line, and the names of the topographers or the source of the base should be stated in the lower left corner, just below the border line. If the title is placed inside the border all notes giving credit for any part or features of the map may be placed beneath the title or scale. (See Pl. VII.)

EXPLANATION.

The symbols, patterns, or colors used on a map should be given in a series of rectangles or "boxes," accompanied by explanatory

[9] Worked out by Martin Solem, of the U. S. Geological Survey.

PROFESSIONAL PAPER 567 PLATE VII



GEOLOGIC MAP OF * *

Scale 1/1,000,000

5 0 5 10 15 20 25 Miles

5 0 5 10 15 20 25 Kilometers

Contour interval 50 feet
Datum is mean sea level
1920

EXPLANATION

SEDIMENTARY ROCKS

Recent	Qal	Alluvium (*stream deposits*)	QUATERNARY
Eocene(?)	Tt	Telluride conglomerate (*pebbles and boulders*)	TERTIARY
		UNCONFORMITY	
Benton group	Kc	Carlile shale (*dark shale containing iron concretions*)	CRETACEOUS
	Kg	Greenhorn limestone (*jointed dove-colored limestone with* * * *)	CRETACEOUS
	Jsd	Sundance formation (*alternating sandstones*)	JURASSIC
	Rd	Dolores formation (*calcareous shale and conglomerate*)	TRIASSIC
Pennsylvanian	Ch	Hermosa formation (*sandstone, shale, and limestone, of grayish* **)	CARBONIFEROUS
	DC	Ouray limestone (*White or light-pink saccharoidal limestone*)	DEVONIAN AND CARBONIFEROUS
	Ci	Ignacio quartzite (*thin-bedded gray or pink wavy quartzite*)	CAMBRIAN
Metamorphic	As	Schist (*dense bluish-gray rocks with subordinate* * *)	ALGONKIAN

IGNEOUS ROCKS

	Tp	Picayune andesite (*intrusive masses and sheets*)	TERTIARY

METAMORPHIC ROCKS OF UNKNOWN ORIGIN

	ARs	Schist and gneiss (*quartz-mica schist, conglomerate, and* * *)	ARCHEAN

Fault

Strike and dip

Axis of anticline

DETAILS OF THE MAKE-UP OF A GEOLOGIC MAP

terms in the form shown in Plate VII, headed "Explanation." If the explanation is small a convenient place for it on some maps may be found within the neat lines. If no space is available there, or if it is so large that there is not room to place it there without obscuring other details, it may be placed either vertically along the right margin, as shown in Plate VII, or horizontally under the title. A geologic explanation should preferably be arranged vertically, as in Plate VII, so as to show the relative age of the formations by the positions of the boxes. This explanation should be carefully worked out in pencil by the draftsman and approved by the committee on geologic names before it is drawn in ink, in order to save time in making corrections.

In lettering the explanation roman letters or type should be used for the titles under the boxes and italic of smaller size for the subtitles or descriptive detail, which should be inclosed in parentheses. The names of geologic periods and systems should be in gothic capitals, the names of series or groups should be in italic lower case, and the limit of each period, system, or group should be indicated by braces. The general style and arrangement shown in the Survey's geologic folios should be followed, and this and the arrangement of other matter is shown in Plate VII. Care should be taken not to crowd the explanation, and if corrections are necessary they should be so made that each line of the matter in which they appear will be properly spaced.

The explanation for a map that is to be engraved or to be reproduced by lithography need only be sketched in to show general style and arrangement. The engraver or the lithographer will supply such matter in proper form according to specifications. For direct reproduction, however, as by photolithography or zinc etching, the lettering must either be carefully drawn with pen or printed from type on slips, which are pasted on the drawing.

GRAPHIC SCALES FOR MAPS.

A bar scale for miles or feet should be given on every map, and if the map is of international interest the metric scale should be given just beneath the scale of miles or feet. The accepted designs for these scales are shown in figure 7. The scale should be accompanied by any necessary statement pertaining to the base map, such as "Contour interval 20 feet," "Datum is mean sea level." The fractional scale ($\frac{1}{250{,}000}$, for example) should be given on all except the more simple kinds of maps, and the date of publication should also appear just below the scale or scales. The single-line bar scale should be used only on small or simple maps. The length of the bar scale must depend on the size of the map and the space available. Those shown in figure 7 were made over blue prints from scales used by the Survey.

To make a bar scale for a map of unknown scale that shows only a single meridian and parallel, or for a map on which no meridians

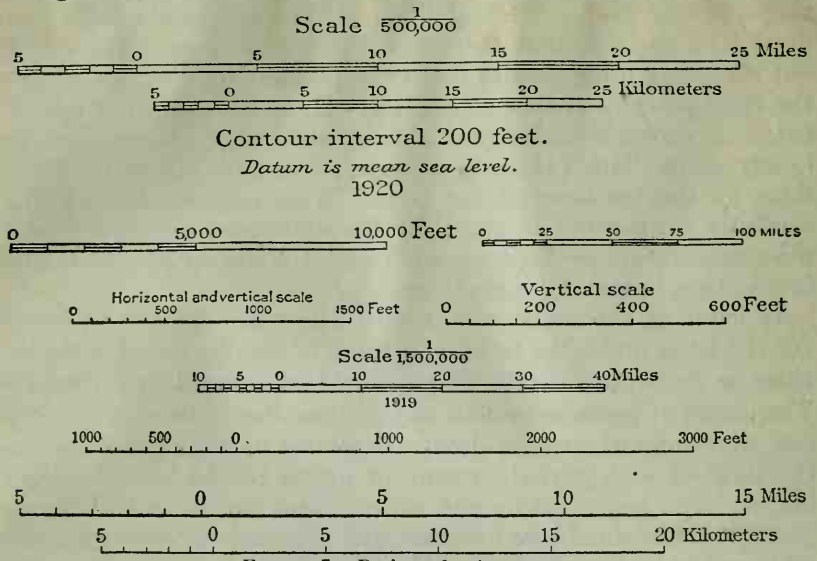

Scale 1/500,000
5 0 5 10 15 20 25 Miles
5 0 5 10 15 20 25 Kilometers
Contour interval 200 feet.
Datum is mean sea level.
1920
0 5,000 10,000 Feet
0 25 50 75 100 MILES
Horizontal and vertical scale
0 500 1000 1500 Feet
Vertical scale
0 200 400 600 Feet
Scale 1/1,500,000
10 5 0 10 20 30 40 Miles
1919
1000 500 0 1000 2000 3000 Feet
5 0 5 10 15 Miles
5 0 5 10 15 20 Kilometers

FIGURE 7.—Designs for bar scales.

or parallels are shown, first ascertain the distance between two points shown on the map by reference to other authentic maps. If, for example, the distance between two such points is 16.315 miles draw a horizontal line (*a* in fig. 8) representing this distance on the map, and at its end, at right angles to it, draw another line (*b*) actually measuring 16.315 units of any convenient denomination. Draw a straight line (*c*) diagonally between the ends of lines *a* and *b*. Then set off on line *b* any convenient number of the units selected, say 5 or 10, and project from the points set off lines exactly parallel with line *c* to line *a*. The distance and the number of the units thus marked on line *a* will indicate the number of miles covered by that distance on the map, as shown in figure 8.

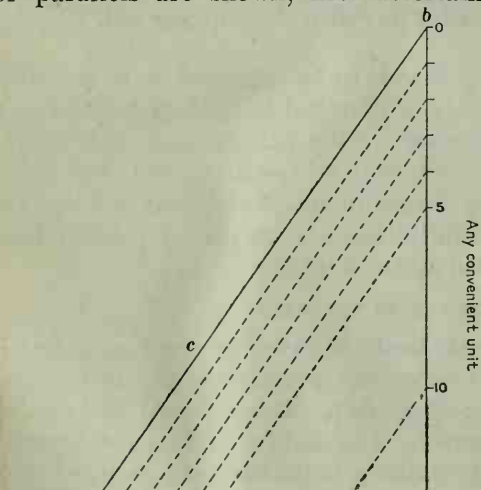
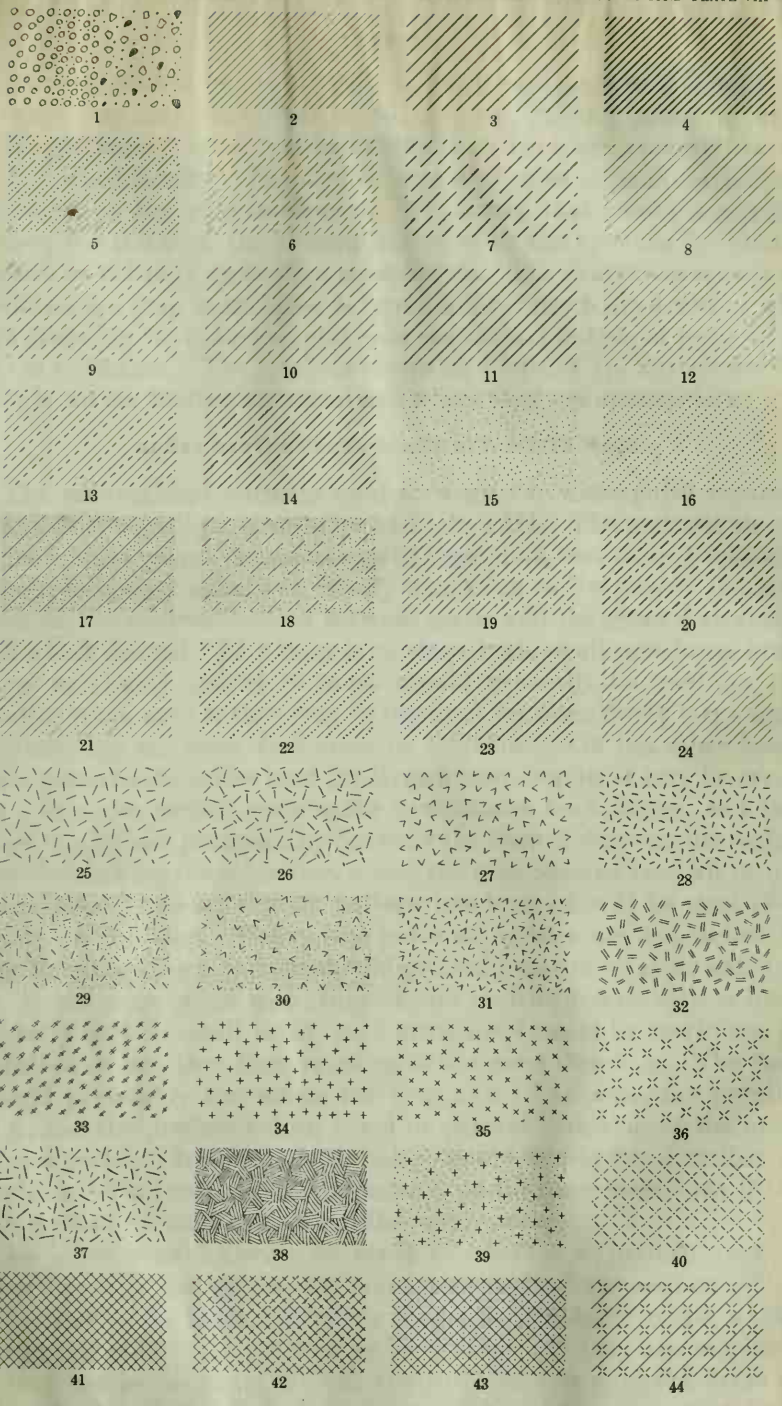


FIGURE 8.—Method of making a bar scale for a map of unknown scale.



PATTERNS USED TO SHOW DISTINCTIONS BETWEEN AREAS ON BLACK AND WHITE MAPS

Contrasts may be increased by varying the direction and spacing of lines

SYMBOLS.

Symbols should be drawn with as much care as letters, though to a critic they may not appear so bad as poor lettering unless he finds them glaringly large or so small that he can discover or identify them only with difficulty. The size of a symbol must depend on its importance on the map bearing it. On a map that shows numerous mines, for instance, the crossed hammers or the symbols for shafts should be not only visible but conspicuous. The draftsman who is to make such a map must know beforehand how much his drawing will be reduced in reproduction and must make the symbols in proportion to the reduction. The symbols shown in Plate II (p. 20) should be used in all the Survey's illustrations where they are appropriate.

AREAL PATTERNS FOR BLACK AND WHITE MAPS.

The conventional patterns used on a map to distinguish separate areas, chiefly geologic, are shown in Plate VIII. The patterns shown represent the proper combinations of lines, dots, and other forms and should be spaced openly or closely according to the size of the area covered, the contrast needed between areas, and the general clearness and effect desired. If a map is to show both small and large areas dense or closely spaced patterns should generally be used for the smaller areas, even if they may be required for some fairly large areas representing the same formation or condition. On the other hand, open patterns should be used for large areas. Again, it may be necessary to make certain areas more conspicuous than others, and this effect can be best produced by drawing the lines closer together rather than by making them heavier, unless the area covered is small or unless a closely spaced similar pattern has been or will be used elsewhere on the map. Heavy-line patterns or bars aré not desirable. The lines forming a pattern should generally be drawn at an angle of 45° to the sides of the map; they should be drawn vertically or horizontally only in small areas or in areas not crossed by meridians or parallels or by other lines running in the same direction. The lines should preferably run across the long axis of an area, not parallel to it, and the predominating trend or general direction of the areas of one geologic formation on a map should decide the direction of the lines for all areas of that formation on the same map, even if the rule must be violated on some of the minor areas.

An effort should always be made to produce a pattern that is subordinate in strength to the main lines of the base map on which it is drawn. In black and white maps, as in colored maps, unlike patterns should be placed next to each other. If they are so placed it may not be necessary to rule the lines on two adjacent areas in opposite directions to produce needed distinctions. A section liner or other ruling device should be used in drawing line patterns in

order to produce uniformly even spacing. The application of six of these conventional patterns to a base map is shown in figure 9.

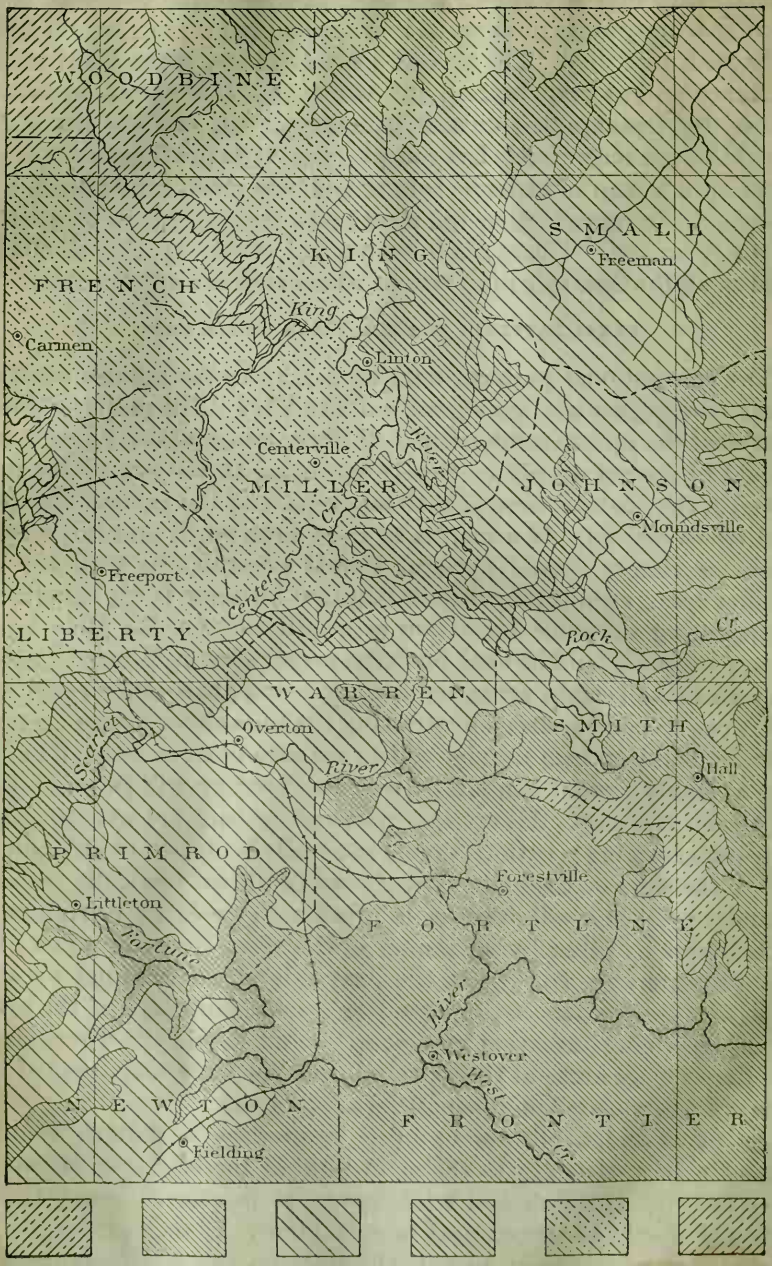


FIGURE 9.—Map bearing six areal line patterns.

STANDARD COLORS FOR GEOLOGIC MAPS.

The standard series of colors for systems of sedimentary rocks is shown on the maps in the Survey's geologic folios but is subject to modifications for use on maps in other Survey reports. Each system is represented by a different color, and if there are two or more formations in one system they are generally distinguished by using different patterns composed of straight parallel lines in the same color. The patterns for subaerial deposits (chiefly Quaternary) are composed of dots or circles, or combinations of both, and may be printed in any color, but the color most often used is yellow or ochraceous orange. No specific colors are prescribed for igneous rocks, but if only a few areas are shown red or pink is preferred. The colors used for igneous rocks are generally more brilliant and purer than those used for sedimentary rocks. For small areas they are used "solid"; for large areas they are reduced in tone by the use of a suitable cross-line pattern or "reticle." Metamorphic rocks are represented by short dashes irregularly placed. These dashes may be in black or in color over a ground tint or over an uncolored area, or they may be in white on a ground tint or pattern. The standard colors used for the sedimentary series covering the 12 systems recognized by the Geological Survey are: Quaternary (Q), *ochraceous orange;* Tertiary (T), *yellow ocher* and *isabella color;* Cretaceous (K), olive-green or *rainette-green;* Jurassic (J), *blue-green* or *niagara-green;* Triassic (Ŧ), light peacock-blue or *bluish gray-green;* Carboniferous (C), blue or *columbia-blue;* Devonian (D), gray-purple or *heliotrope-gray;* Silurian (S), purple or *argyle-purple;* Ordovician (O), red-purple or *rocellin-purple;* Cambrian (Ꞓ), brick-red or *etruscan red;* Algonkian (A), terra cotta or *onion-skin pink;* Archean (Ar), gray-brown or *drab.*[10]

REDUCTION OR ENLARGEMENT OF MAPS.

The following is the simplest and most accurate method of marking the reduction or enlargement of a map to a selected scale: Measure the distance between the extreme meridians along one of the parallels. (See fig. 10.) Convert this distance into miles by multiplying the number of degrees it covers (say 3) by the number of miles in a degree. A degree on the forty-third parallel, for example, is 50.669 miles,[11] which multiplied by 3 equals 152.007 miles. Then draw a line on the margin of the map, outside the border, the exact length of the 3 degrees, and just below this line draw another line representing the same number of miles (152.007) on the scale to which the map is to be reduced or enlarged. Then mark to reduce or enlarge the upper line to the lower line, as shown in figure 10. A

[10] Names printed in italic are from "Color standards and nomenclature," by Robert Ridgway.

[11] See U. S. Geol. Survey Bull. 650, p. 37, 1916.

long line will reduce error and give greater accuracy than a short one, and therefore as great a distance should be set off as possible. The number of miles represented by both lines and the fractional scale to which it is to be reduced should be stated on the drawing, for permanent record.

Maps that will bear reduction without affecting the clearness of the details they show may be reduced to fit the book in which they are to appear, regardless of definite scale. The reduction for such maps is best marked in fractions, as "½ off," "⅓ off," "⅔ off." If

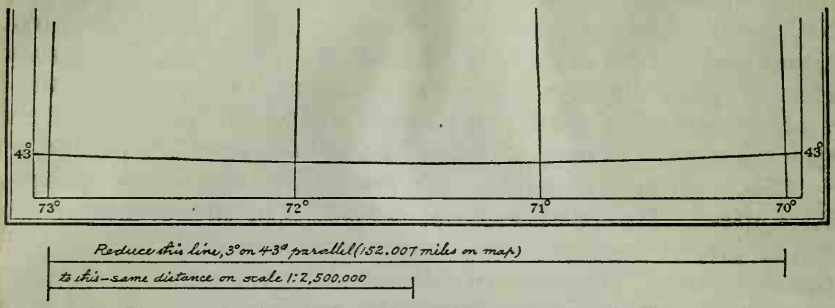


FIGURE 10.—Diagram showing method of marking maps for reduction or enlargement (for record).

the size needed is not exactly represented by these fractions it should be indicated in inches, as "Reduce this line to 7½ inches," or "Reduce to 4⅜ inches in width."

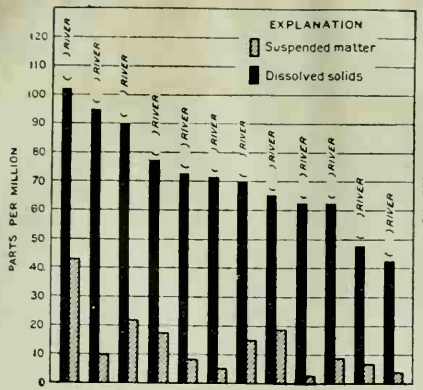
DIAGRAMS.

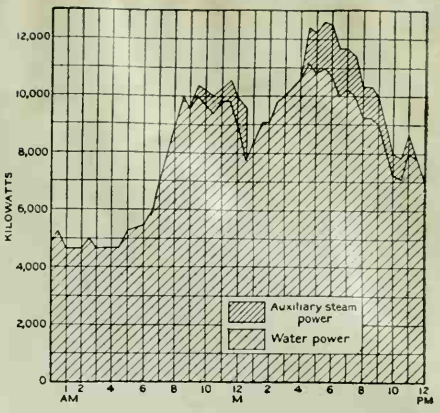
In preparing a diagram a draftsman should endeavor to make its parts and relations perfectly clear to the reader. He should study the drawing or material furnished by the author until he fully understands it and should endeavor to reproduce it simply and legibly. Any lettering that may be needed should generally be in plain upright or slanting gothic type (see Pl. IX), or it may be in roman.

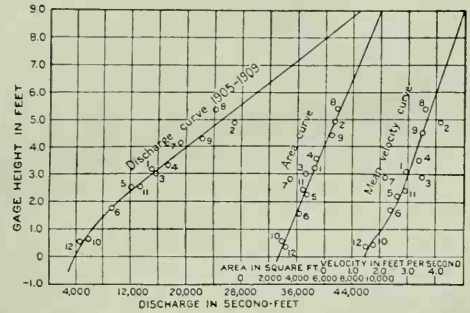
A diagram should generally be drawn on bristol board or on blue-lined section paper and should be marked for reduction to the minimum size. It should bear no title, as the title will be set up in type by the printer.

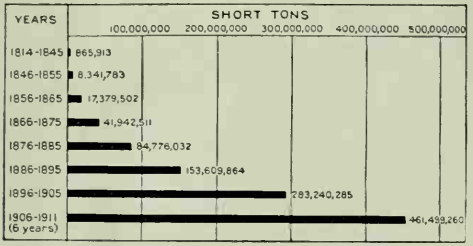
SECTIONS.

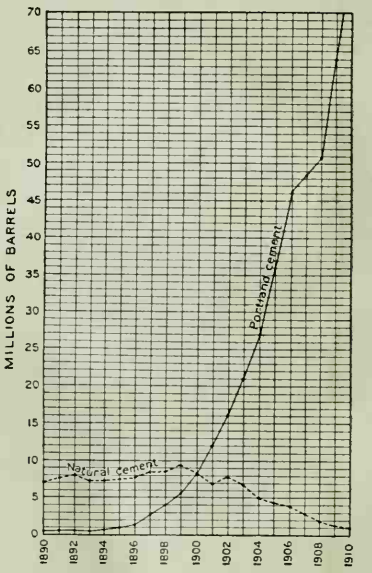
The sections used in geologic reports are of two widely different kinds. One shows only the broader relations of parts; the other shows details of structure as well as relations. One is diagrammatic; the other is more realistic and graphic. The draftsman should prepare all sections strictly according to the copy supplied by the author but should use proper symbols and make a more finished drawing. The various kinds of sections, most of them geologic, are described

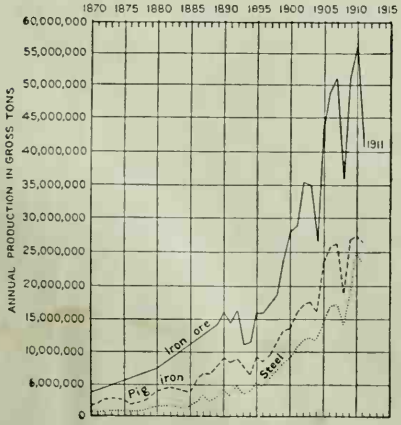


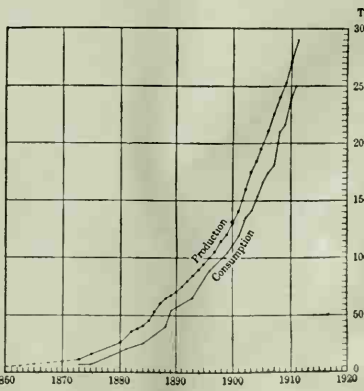












DIAGRAMS AND CURVES.

on pages 29–30, and the conventions used to express lithologic character are shown in Plate III.

Detailed drawings of this kind, though entirely conventional, can be so prepared as to give a satisfactory expression of nature. The draftsman should study well-prepared sections in Geological Survey reports and should learn the details of folding and faulting from textbooks. He should first ascertain whether or not the vertical scale in the original section has been unduly exaggerated, and if so he should confer with the author with a view to reducing the exaggeration as much as possible. He should submit to the author all questions as to doubtful points, as well as all suggestions for improvement in expression, before he makes any changes, and he should make corrections only on the author's approval. A seeming inaccuracy in an author's drawing may be a faithful representation of natural conditions. For example, a formation that seems to be omitted by inadvertence in drawing may really "pinch out" at a point represented in the section. (See *a* on fig. 11.)

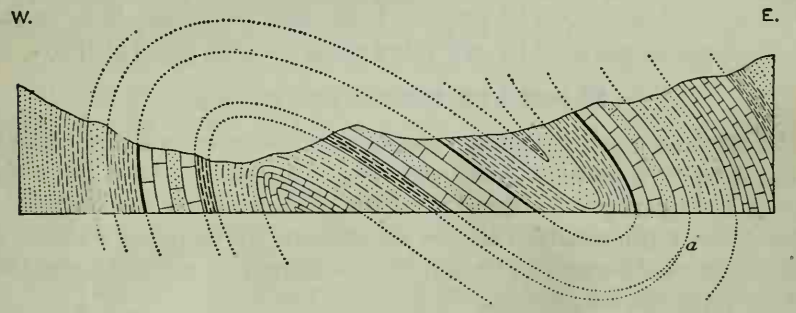


FIGURE 11.— Structure section showing method of determining the succession of folds.

Pencil lines corresponding to those shown by dots in figure 11 should be carefully added in redrawing a roughly sketched section that shows complex folding. An original indefinite sketch that shows complicated structure affords opportunities for error in preparing the new drawing, and omissions may be detected by following the formations as they would be continued above and below the section, as shown by the dotted lines in the figure.

PLANS AND CROSS SECTIONS OF MINES.

Plans of mines, like diagrams, should not be elaborate, and their lettering should be plain and legible, yet it should not be so conspicuous as to obscure other details. Gothic letters should generally be used, but some plans require different styles of lettering, especially for geographic or other names that should be coordinate with those on maps or other illustrations in the book. Unless there are good reasons, however, for varying the styles of lettering, plain

gothic capitals, or capitals and lower-case letters, either upright or slanting, should be used. Abbreviations for the numbers of levels should generally be given thus: 3d level, 6th level, 200-foot level, etc., or the shorter terms may be spelled out, as third level, sixth level. The same general scheme of lettering should be used on all plans and cross sections that are to appear in one publication or in one series of similar papers.

The reduction of such drawings to the minimum scale consistent with clearness is always advisable.

DRAWINGS OF SPECIMENS OF ROCKS AND FOSSILS.

METHODS USED.

Drawings of specimens or other objects were once made with brush and pencil or with pen and ink, by means of measurements taken with dividers or by viewing the specimen through a camera lucida. Each of these methods is still used, but by using the camera lucida in sketching the outlines and details more accurate proportions and relations can be produced, whether the object is to be enlarged or reduced, than by any other means except photography.

BRUSH AND PENCIL DRAWINGS.

In all drawings or photographs of specimens, except photomicrographs of thin sections, the light should appear to come from the upper left quarter. A disregard of the well-established rule that the direction of illumination should be uniform throughout a series of drawings would cause confusion or uncertainty in the interpretation of the relief shown in them.

Reynolds's three-ply and four-ply bristol board affords a satisfactory surface for brush and pencil drawings. Its surface is smooth and hard and, being free from coating of any kind, permits satisfactory erasures without great injury; its color is pure white; and it is durable.

Ross's relief hand-stipple paper is also well adapted to many kinds of brush drawings as well as to its primary use for producing stippled effects. Very delicate gradations of color or light and shade can be produced on its surface with brush and lampblack or with india ink, and high lights can be made by scraping off the chalky surface.

The draftsman who is preparing brush and pencil drawings should have first of all a knowledge of the principles of light and shade, of reflected light, and (for drawing specimens) of shadow perspective. He should also have delicacy of touch and ability to see and interpret form and to reproduce the soft blending of light and shade shown in a good photograph. He should be provided with pencils equal in quality to the Koh-i-noor B, F, 4H, and 6H;

the best quality of red sable brushes of the sizes of Winsor & Newton's Nos. 3, 4, and 6; the best quality of stick india ink; a cake or pan of lampblack; and a porcelain saucer or slab.

In drawings of fossils and of some other specimens a combination of pencil and brush work produces satisfactory results and tends to increase speed. The gloss produced by penciling, however, is objectionable and should be obviated by a preponderance of brush work. Stick India ink is the best pigment to use in delicate wash drawings, and lampblack is preferable for large work on which the softer tones of the shading are not so important and for drawings that are to be considerably reduced when engraved. Gouache (an opaque mixture of Chinese white and lampblack) may also be used, but it is best suited for large work.

In making corrections on brush drawings the parts to be corrected should be carefully washed out with a small short-cropped brush and water and still further cleaned by using a rubber eraser over an erasing shield or an opening cut in a piece of celluloid. Erasures should not be made on delicate work with a knife or a sand rubber, as either will injure the surface and affect reproduction. In measuring a specimen with dividers the draftsman should be careful not to injure the specimen or to puncture the paper on which he is preparing the drawing.

PEN DRAWINGS.

A draftsman who is preparing drawings of specimens with pen and ink should have a good assortment of pens equal to Gillott's Nos. 291, 290, and 170, liquid waterproof ink equal to that manufactured by Higgins, good pencils, hard and soft rubber erasures, plain dividers, and Reynolds's bristol board. A glass eraser is also useful.

Good pen drawings of specimens are much more difficult to make than brush drawings. They can be prepared only by a draftsman who has had some artistic training and experience in pen work. Few draftsmen can prepare pen drawings that faithfully represent both the detail and the texture of specimens; the shading on many such drawings confuses and destroys both detail and texture.

The pencil sketch over which a pen drawing of a specimen should be made must be prepared in much the same manner as the sketch for a brush drawing, though the outlines need not be so delicate. This sketch is generally made on bristol board. The pen work should begin with the outlines and should then be carried to the details, and finally to the shading, whether in lines or stipple. The texture of a specimen is the best key to the proper shading. If the specimen is decidedly granular, stippling is appropriate; if it is smooth or polished, finely drawn parallel lines, varied in spacing and character according to depth of shade and texture, are preferable.

Erasures can be made with a hard-rubber eraser, other parts being protected by a shield, or with a very sharp knife or a glass eraser, and the parts erased can be resurfaced with an agate burnisher.

RETOUCHING PHOTOGRAPHS OF SPECIMENS.

Photographs of specimens, particularly fossils that have been coated to destroy local color, should be printed on velox paper, in a tone somewhat lighter than that of ordinary photographs. The details and relief should, however, be strong enough to enable the draftsman to see them clearly, so that by retouching them and strengthening the shadows and high lights he can make them sufficiently strong for reproduction. This he can do by a combination of pencil and brush work, the pencil being used sparingly because the gloss produced by the graphite is likely to affect reproduction. A No. 3 Winsor & Newton's red sable brush and lampblack are preferable for the greater part of this work, and a 4H and a 6H pencil for the fine details and as a possible aid in producing the finer gradations of shading. The details should be retouched or strengthened under a reading glass to insure accuracy; the broader effects can be best produced without the aid of a magnifier.

Erasures on photographs of specimens should be made very carefully with a hard rubber that is free from sand, and the parts not to be disturbed should be protected with a shield. High lights may be added by carefully scraping or rubbing the surface of the paper.

LANDSCAPE DRAWINGS FROM POOR PHOTOGRAPHS.

A poor photograph or one that has become injured and can not be retouched for direct reproduction can be utilized by making from it, as described below, a pen drawing or a brush or crayon drawing, which will be almost photographically correct.

PEN DRAWINGS MADE OVER PHOTOGRAPHS.

A pen and ink drawing may be made over a blue print or a bromide print (preferably a blue print) and the photographic image then bleached out. The blue print should be larger than publication size and should not be so dark that the draftsman can not see his lines. If the negative is available a bromide enlargement can be obtained; otherwise the picture should be rephotographed in larger size, preferably twice publication size. The enlargement will give the draftsman greater freedom in drawing details and will make his work appear finer and better in the reduced illustration. If the photographic print is of a subject requiring the use of instruments it should be securely fastened to a drawing board, square with the board, so that any horizontal and vertical lines in it may be ruled by the use of a

T square and triangle. For specimen or landscape work it need not be fastened.

For bleaching blue prints a saturated solution of oxalate of potassium ($K_2C_2O_4+H_2O$) has been used with good results. For bleaching bromide prints cyanide of potassium (KCN) to which a few drops or flakes of iodine have been added should be used. Neither kind of print should be bleached until the drawing has been completely finished in every detail, because bleaching loosens the fibers of the paper, so that the ink of any added lines is likely to spread. The print should be placed in a hard-rubber pan, the bleaching solution poured on it, and the pan rocked until the image disappears. The print should then be carefully removed, thoroughly washed in running water, placed between clean white blotters to dry, and finally mounted on cardboard. For temporary, hurried work on drawings that are not to be retained for future use the blue print may be mounted first and bleached by pouring the bleaching fluid over the mounted print.

BRUSH DRAWINGS FROM POOR PHOTOGRAPHS.

Brush drawings may be made directly from photographs by working over an enlarged print with gouache, or by making a pencil tracing and sketch of the photograph and working it up with lampblack or india ink. The photograph should be larger than publication size to permit greater freedom and breadth in drawing details. The larger size will also afford a more refined and better engraving when reduced. If lampblack or india ink is used and the subject is small, bristol board is recommended, but if the photograph is larger than, say, 8 by 10 inches, Whatman's hot-pressed double elephant or similar paper, laid down with thumb tacks, will prove satisfactory.

If gouache is used over a print a preliminary drawing is of course unnecessary, but the photograph should be an unglazed print of a size that will require considerable reduction, and the finished drawing should be protected by an oversheet. If lampblack or india ink and not gouache is used the photograph should be traced and a fairly complete pencil sketch should be made before the brush is used.

Plates I, IV, *A*, V, *B*, and VII, *B*, Monograph 34, were made from gouache drawings. Plates III, *A*, VII, *A*, X, XI, XII, XIII, XX, XXVIII, and XXX, in the same publication, were made from lampblack or india-ink wash drawings. The originals can be examined at any time.

OUTDOOR SKETCHES.

The art of sketching from nature is one in which few but professional artists excel. Not many geologists are able to make sketches from nature that are suitable for direct reproduction. An artistic draftsman should be able to redraw the geologist's sketches, however,

in their true perspective and relations, with the skill necessary to make them satisfactory illustrations.

In most crude outdoor sketches the important features are usually shown with sufficient clearness to follow. If they are not the draftsman should ascertain what those features are and prepare the new drawing in such a way as to display them properly. The new drawing should be made with pen and ink, generally for reduction to a text figure, which is the most appropriate form for such an illustration.

In all sketches of this kind the lines should be drawn in such a way as to produce natural effects and at the same time to make good printing plates. Good examples of pen and ink sketches of this class can be found in Monograph 34, already referred to, and in the Seventh Annual Report, especially Plates XXVIII and XXXVIII; Ninth Annual Report, Plates XLIII and XLIV; Tenth Annual Report, Plates XIV and XIX and figure 58; Eleventh Annual Report, Plates XV, XXVII, XXXV, LII, and LIV and figures 18, 30, 31, 67, 98, and 99.

DRAWINGS OF CRYSTALS.

A crystal should generally be drawn in outline with straight lines. The invisible rear side of a crystal, if shown, should be represented by dashed lines. The outer boundary line of a crystal should be slightly heavier than the inside lines, which should all be of the same weight. Striations should be shown by straight lines; broken or uneven surfaces by irregular lines. A twinning line, if an intersection edge, should be solid; if not an intersection edge it should be broken into dashes. Italic, Greek, German, and Old English letters are used to mark crystal faces. All faces of a given form should be marked by the same letter but may be differentiated, if necessary, by primes or numerals, thus: m, m′, m″, m‴, m^{IV}. "Leaders" should be short full lines, or, if these are likely to be confusing, they should be dashes. Numbers may be used in place of letters for specific purposes. Letters indicating twin faces are underscored; a second twin is doubly underscored or overscored, thus: $\underline{m}$, $\underline{\underline{m}}$, $\overline{\overline{m}}$. Twin units may be differentiated by the use of roman numerals.

RETOUCHING PHOTOGRAPHS.

An author, of course, selects his photographs to illustrate some special features; he does not always consider their fitness for reproduction. Photographs that are blurred or out of focus, those in which the shadows are too black or lack transparency, and those which have local defects, such as bad skies or spots, must be worked over to make them suitable for reproduction. In order to remedy these defects and produce natural results the draftsman doing work of this sort should be able to see and interpret nature properly and

to supply natural effects in a manner corresponding with those produced photographically. He should be sufficiently expert with the brush and pencil and in handling an air brush to duplicate the delicate and soft tones in the photograph, and he should know how the pigments he uses will "take" when the subject is reproduced.

The retoucher should have access to an air brush and should provide himself with a jar of photo white or blanc d'argent and a color box containing indian red, crimson lake, yellow ocher, lampblack, and ultramarine—colors with which he can duplicate those shown in any photograph. He should also have the best grade of red sable brushes, ranging in size from No. 3 to No. 8, a stack of porcelain saucers, and a jar of oxgall. By mixing the colors to match exactly the shades of a photograph and using a red sable brush he can strengthen details, "spot out" flaws, and remove imperfections, except those in skies or other large, flat areas, for which he must use an air brush.

The air brush has become a necessary adjunct to a retoucher's outfit. Smooth, even gradations of flat tones can not be successfully applied to photographs without it, and it is therefore indispensable, especially for retouching skies and covering other large areas.

Before retouching a photograph the draftsman should mix in a saucer a tint that will match the color of the part that is to be retouched and should try this tint and note its effect after it has dried and change it, if necessary, until it matches the color exactly. If he is to retouch a number of photographs that have the same local color he may with advantage make up enough of the tint for the entire lot, thoroughly mixing it and seeing that it is not too thin. In making this tint he should use only pigments of the best grade, and if he finds that the Chinese or other white he is using does not photograph well, or that it does not hold its color, he should discard it at once and use another brand. Photographs that are to be retouched should be large enough to permit sufficient reduction to soften the effects of retouching.

In order to eliminate the lines of junction between two or more photographs that are joined together to form a panorama some adjustment or fitting of details by retouching is generally required before the group is rephotographed to obtain a new print of the whole on one piece of paper. As it is often desirable to increase the width of such an illustration the photographer should be instructed to print the photograph on a strip of paper that is wider than the negative, so that, if necessary, the retouching may be carried above or below the new print to add depth to the illustration.

Panoramas may also be drawn from photographs with either pen or brush in the manner described on pages 68–69.

PART III. PROCESSES OF REPRODUCING ILLUSTRATIONS.

METHODS EMPLOYED.

The preliminary work in producing illustrations includes the preparation, from originals submitted by authors, of drawings and other kinds of "copy" in such a way that the copy can be reproduced in multiple by printing.

Several processes are used for preparing plates for printing illustrations, and each has its peculiar features of excellence. One process may render fine details with facility but may fail in uniformity in large editions; another may be cheap and effective on the whole but may not reproduce fine details; and still another may give fine color or tone effects but may be too expensive. Therefore a knowledge of the varied uses and results and of the cost of the several processes of reproduction and, on the other hand, of the kinds of originals that are best suited for reproduction by any one of the processes is essential to effectiveness and economy in planning, preparing, and reproducing an illustration.

The following condensed descriptions of processes are intended mainly to aid in determining the kind of copy that is appropriate for each process and the kind and quality of reproduction to be expected, so that only the principal operations or stages in each process are described. Wood engraving, which was used in making printing plates for many of the illustrations in the early publications of the Geological Survey, is described here only to compare that laborious and "indirect" method of engraving cuts with the more modern kinds of relief engraving. In 1892 it gave way to photo-engraving.

PHOTO-ENGRAVING.

GENERAL FEATURES.

The term "photo-engraving" is applied to processes by which a black and white line drawing, photograph, or like original is reproduced in relief on a metal plate from which prints may be made on an ordinary printing press, in distinction from processes that print from flat or relatively flat surfaces, such as the lithographic and photogelatin processes. The photo-engraving processes that are most generally used are those called "zinc etching" and "half-tone engraving." These processes depend on the discovery that gelatin or

similar organic material, if treated with potassium or ammonium bichromate and exposed to the action of light, is made insoluble in water. If a metal plate coated with bichromatized gelatin or albumen is exposed to light under a negative the parts acted upon by light become insoluble and those not acted upon remain unchanged and may be washed away so as to expose the metal, which is then etched with acid in order to give relief to the unexposed parts and make of them a printing surface.

ZINC ETCHING.

Zinc etching is adapted to the direct reproduction of a pen and ink drawing composed of lines, dots, or solid black areas. On the finished metal plate these lines, dots, and solid areas form the printing surface, and the spaces between them, which have been etched away, represent the white or blank parts of the picture. The process is cheap and is almost universally used for reproducing small drawings designed for text illustrations. It is also well adapted to the reproduction of maps and diagrams measuring in print not more than about 10 by 14 inches. One of the chief advantages of this and of all other direct (photographic) processes of engraving is that they reproduce a drawing in facsimile, whereas the "personal equation" must enter into all engravings made by an indirect method—that is, by hand—such as wood engraving, wax engraving, and engraving on stone or copper, which make it necessary to compare every detail of the proof with every detail of the drawing before the engraving can be approved. The pen drawing to be reproduced, which should preferably be considerably larger than the completed engraving, is first photographed to the proper size or scale on an ordinary negative film. The film is then stripped from the negative and reversed in order that the etched plate may print the design as in the original and that the film may be grouped with other films on one large glass and all printed at the same time. The negative (whether a single film or several) is then placed in a specially constructed printing frame in contact under pressure with a sensitized zinc plate and exposed to light.

After the zinc plate has been removed from the printing frame (in the dark room) the plate is rolled with printer's transfer ink, which resists acid, and placed in a shallow tray containing water, in which it is rocked for several minutes, and then taken out and rubbed gently with cotton. The parts of the coating of the plate that were acted on by light have become insoluble and will therefore be unaffected by the water, but the parts of the coating not acted on by light and therefore not hardened will be removed by the washing, which will expose the metal and leave the parts acted on by light—

the picture—in black lines, dots, etc. The plate is then dusted with "topping powder," a resinous substance which adheres only to the parts carrying the ink. The plate is then heated so that the resin and the ink that remain fuse together and form, when cooled, a resistant surface which will not be affected by the acid to be used later in etching the unprotected parts of the plate.

The plate is now ready for a preliminary etching in a fluid consisting of water and a few drops of nitric acid. It is placed in a tray, rocked gently for a short time, and then removed, washed well in running water, drained, and dried with gentle heat. "Dragon's blood," a resinous powder that resists the action of acid, is next applied to the plate, in order to protect the sides of the lines and the dots from the acid, and the plate is then heated just sufficiently to melt the powder and unite it with the ink. A small quantity of nitric acid is now added to the etching bath, and the plate is subjected to its first thorough biting or etching. It is then removed from the bath, washed under a tap, carefully wiped with a damp rag, and dried with gentle heat.

The plate is thus treated three or more times until it is etched deep enough to insure satisfactory printing, and it is then ready for finishing, which consists of deepening the larger open spaces between the lines with a routing machine and of cutting away with hand gravers lines that are improperly connected or that are so close together that they will not print separately. The routing machine is provided with a cutting tool mounted on a revolving spindle that projects downward into the engraved plate, which is securely fastened. The movement of the arm that holds the cutter is universal and can be controlled with great precision. The plate is then "proved"—that is, a proof is taken from it on paper—and if the proof is satisfactory the plate is nailed to a block of wood on which it will be "type high" (0.918 inch), for printing.

Most drawings for zinc etching are made with a pen in black ink and consist of lines, dots, or masses of black, but drawings may also be prepared by using some medium that will produce a fine stipple, such as a black crayon on rough paper or Ross's stipple paper. (See p. 24.) The drawing should be one and one-half to two or three times as large as the printed illustration, for it is impossible to obtain a satisfactory reproduction of a pen and ink drawing without some reduction. If the drawing has not been reduced the lines appear heavier in the reproduction than in the drawing, and imperfections thus become more noticeable; if it has been properly reduced, imperfections are diminished and the lines and dots become thinner and finer than those in the drawing. In making a drawing that is to be reduced the draftsman can also space his lines farther apart and work out his details more easily.

An author should carefully examine and approve the finished drawings, which can, of course, be greatly altered, if necessary, before they are engraved; but similar corrections can not be made on proof sheets of zinc cuts, which should not be marked for alterations except by eliminating parts. Minor changes can be made in such a cut by an expert "finisher," but if the cut is small it is generally cheaper to correct the drawing and have a new cut made.

Zinc etchings cost about 10 to 25 cents a square inch, the cost being varied according to a standard scale which is based upon the ascertained cost of reproduction. The minimum charge for a single cut is $2.

COPPER ETCHING IN RELIEF.

Copper etching, which produces a line cut in relief, requires the same kind of copy that is most often marked for zinc etching and is used to obtain deeper etching and a more permanent cut. It is said to produce better printing plates than those etched on zinc and is used largely for reproducing script lettering and other fine work. As copper plates will hold up longer in printing than zinc, a cut etched on copper may not need to be electrotyped.

The chemical part of the process is practically the same as that employed for etching half-tone plates, described under the next heading.

The cost of etching on copper is considerably greater than the cost of etching on zinc. This process is not often used in reproducing illustrations for publications of the Geological Survey.

HALF-TONE ENGRAVING.

The half-tone process is, in name at least, familiar to almost everyone who has had any connection with the making of books, whether as author, editor, illustrator, or printer. The invention of a photomechanical process of reproducing a line drawing to make a metal plate that could be printed along with type on an ordinary printing press naturally led to attempts to reproduce similarly a photograph. It was known that the intermediate shades between white and black in a photograph—the half tones—can be reproduced on an ordinary printing press only by breaking them up into dots or lines that will form a good printing surface and that by their variation in size or density will give for each shade the effect of a uniform tone. In the half-tone process this effect is produced by photographing the picture or object through a screen.

The half-tone screen consists of two plates of glass, on each of which lines running generally at an angle of 45° to the sides of the plate have been engraved, cemented together so that the lines cross at right angles. The lines, which are minute grooves filled with an

opaque black pigment, thus appear as a series of black crossed lines on a white ground. The screen is placed in the camera in front of the negative. Screens are made that show from 50 lines to an inch for the coarser newspaper illustrations to 250 lines or more to the inch for fine book work. The screens used for magazine illustrations generally show 120 to 150 lines. Those used for Survey publications show 150 to 175 lines, and for reproducing delicate drawings and photographs of fossils screens bearing 200 lines to the inch are sometimes specified; but these finer screens require the use of highly supercoated papers, some of them made of cheap fiber and not known to be permanent. For a half tone that is to be printed in the text a 100-line or a 120-line screen is specified. (See Pl. VI, p. 56.)

The method of etching a half-tone plate does not differ greatly from that used in zinc etching, and there are several kinds of half-tone plates, though most of them are etched on copper, not on zinc, those etched on zinc being used principally for newspaper illustrations. The half-tone screen is used also in other processes to obtain a negative.

When a half-tone negative has been made the film is stripped from the glass plate and reversed, as in the zinc-etching process, though some half-tone engravers use a mirror box or prism by which the picture is so disposed on the negative that it does not need stripping and reversing. A perfectly flat, clean, and highly polished copper plate, generally large enough to accommodate several such films, is then coated with a sensitive film according to one of several formulas, all based on the fact that gelatin or some similar body, if sensitized with certain chromic salts, becomes hardened and insoluble in water on exposure to light. This plate is then placed in the printing frame in contact, under pressure, with the glass negative plate and is exposed to light in the usual manner. The copper plate is then removed from the frame in the dark room and made ready for etching.

For etching half-tone plates on copper a saturated solution of perchloride of iron is used instead of the solution of nitric acid used for zinc etching. The time of etching ranges from about 5 to 15 minutes, according to the strength of the solution. One etching is generally sufficient, but it may be necessary to give the plate another "biting" if it has not been etched deep enough, or to re-etch it in order to strengthen contrasts. If, for instance, the sky in a half-tone plate shows too dark or is uneven in tint it can be made lighter or more even by re-etching. On the other hand, if certain features on a plate are too light they can be darkened by burnishing—rubbing the surface with a highly polished steel burnisher under just sufficient pressure to flatten slightly the fine points that form the printing surface of the plate. When the plate leaves the hands of

the etcher it is turned over to the finisher, who with a graver removes spots or any other imperfections that may appear on it. Sometimes a roulette is used to lighten parts, and other tools are used for special purposes.

After a plate that shows two or more pictures has been etched and finished it is divided by sawing them apart. Each one is then put into a beveling machine, where its edges are trimmed and the usual border is made, if it is desired. The separate plates are then ready to be proved and mounted on blocks of wood which make them type high, ready for printing.

The half-tone process is used almost exclusively for reproducing photographs and wash drawings, though it will produce a facsimile of any kind of copy, such as impressions from type, old manuscripts, or typewriting, but a shade composed of minute black dots will appear over the entire print and there will be no absolutely white areas unless they are produced by routing the plate or cutting out the high lights. (See p. 74.) The reproduction of an ordinary outdoor photograph requires very little handwork, except for re-etching, burnishing, and cutting the borders. In the reproduction of copy that is made up of separate parts, such as groups of photographs of specimens that are to appear on a white ground, the half-tone "tint"—or more properly shade—between and around the several figures must be removed and numbers must be added. This operation requires two negatives—one half tone and one line—and produces what is called a "combination" plate. Therefore the difference in the cost of making a half-tone cut from a single photograph of a landscape and from a cut made from "copy" of the same size consisting of a number of small photographs or drawings, to which numbers or letters are added, is considerable (about 50 per cent greater) and depends upon the amount of additional work involved. Routing, when needed, must be done with extreme care lest the edges of a figure be marred, and this work requires skill that can be gained only by experience.

Copy for the half-tone process should be as nearly perfect as possible. Only the best photographs should be selected. Prints on semimat velox and glossy haloid papers are regarded as the best photographic copy for reproduction. Every part of the photograph or drawing should be absolutely clean. If any part that should be pure white becomes soiled or stained the defects will be reproduced. If a photograph needs retouching it should be retouched with great care and just sufficiently to correct defects and to bring out or strengthen the important details. In many photographs the skies may be "muddy" or uneven in tone, and this defect can be corrected by the use of an air brush, the only medium that will produce an almost even tone. As already stated, half-tone plates can be im-

proved by re-etching and tooling, but tooling tends to destroy the effects of nature and produces an artificial appearance in the print. One who is preparing wash drawings for reproduction by the half-tone process should remember that brush marks and other inequalities of tone will be reproduced with as much fidelity as other details. Such drawings should therefore be made two or three times larger than the engraved cut in order to subdue all unnatural effects and to soften the general tones.

Line drawings are not generally suitable copy for the half-tone process, but it is occasionally desirable to use that process instead of zinc etching for reproducing a line drawing that has been inexpertly prepared if the cost of redrawing would more than offset the difference in cost between zinc etching and the more expensive half-tone process. In reproducing a pen drawing by half tone the lines become softened and represent the details and shading only; but the pen drawing may be further developed by brush work. Examples of this type of reproduction are Plates V, *A*, VI, *A*, and XV, figure 10, and other illustrations in Survey Monograph 34.

Vignetting, which consists of a skillful grading off of the edges of a picture, as well as extensive tooling or hand engraving, is often employed for artistic effect but should be specified only for exceptional illustrations. The plates made for the Survey are either "square trimmed" or the ground tint is entirely omitted or routed away; they are not usually tooled or vignetted.

Half-tone cuts etched on copper cost 20 to 60 cents a square inch, the cost being varied according to a standard scale based on the ascertained cost of reproduction. Those that require a screen finer than 150 lines cost 25 per cent additional. The minimum charge for a single cut is $3.

Half tones etched on zinc (100-line screen or coarser) cost 25 per cent less than those etched on copper.

THREE-COLOR HALF-TONE PROCESS.

The three-color process is practically an adaptation of the half-tone process to color printing based on the theory that all colors or hues in nature can be reproduced by combinations of three colors of the spectrum—red, blue, and yellow. The process differs from the ordinary half-tone process particularly in the use of color filters in making the negatives and in the character of screens and diaphragms used. This process, like all others, is worked somewhat differently in different establishments. In what is called the indirect method, the one most commonly used, twelve photographic operations are necessary to produce one illustration, or the three plates or cuts from which one illustration is to be reproduced by printing. These twelve

operations produce three chromatic negatives, each representing one color; three transparencies or positives, made from the chromatic negatives; three half-tone negatives, made from the positives; and finally three contact prints, made on sensitized metal plates. In what is called the direct method the half-tone screen is placed in front of the photographic plate so that it becomes also a half-tone negative from which a print is made on a sensitized metal plate. Thus the photographic operations in the direct method are reduced to six, but the interference to the passage of light offered by the half-tone screen and by the prism used to reverse the image on the negative lengthens the time of exposure.

Unfortunately, no pigments have been found that can reproduce in purity the colors of the spectrum, and to this fact is due the failure of the process to reproduce exactly all the colors, tints, and shades of an original. When a drawing in black on white paper is photographed only the white paper affects the negative film. The transparent parts of the developed negative thus represent the black, and the opaque parts, which have been acted upon by light, represent the white. Theoretically, when a chromatic negative is made for the yellow plate a purple-violet filter cuts out all the yellow and allows the red and blue rays to affect the plate; when a negative is made for the blue plate an orange filter similarly cuts out the blue and allows the yellow and red rays to affect the plate; and when a negative is made for the red plate a green filter cuts out the red and permits the blue and yellow rays to affect the plate. These color filters, which are usually made of transparent stained gelatin, are generally placed in front of the lens. When printing plates like those used in the half-tone process have been made from the three negatives and the plates have been inked with yellow, blue, and red ink, respectively, a combined impression from them will produce a close approximation of the subject photographed. The colored inks often used are light yellow. peacock or prussian blue, and bright, transparent crimson.

The ordinary half-tone screen, which bears lines cut at an angle of 45° to the sides of the plate, is rectangular, but the screens used for three-color work are made circular in order that they may be turned in the camera to make the lines intersect at other angles, the angles being varied to avoid producing an undesirable pattern or a moiré effect. Turning the screen also prevents the exact coincidence or superposition of the red, blue, and yellow dots, which would produce black. In other respects the screens do not differ essentially from those used in ordinary half-tone work.

As special experience is necessary in printing three-color plates the engraver generally delivers the printed illustrations to the purchaser

instead of the plates, which he furnishes for other kinds of relief printing.

The copy for this process may consist of anything in color, such as specimens, objects, paintings, or properly colored photographs. The process does not usually reproduce all the colors and tints of an original with equal exactness and is not used by the Survey for work that demands precise reproduction of color, but it is satisfactory for reproducing most colored drawings, colored photographs of specimens, or the specimens themselves if they show individual variations in color. As the process is entirely photomechanical it gives more scientific accuracy in detail than chromolithography, in which there is much hand work, and it is much less expensive. If the colors shown in proofs are not satisfactory they can be modified.

The four-color process, in which four color plates are used, gives a closer approximation of true color values than the three-color process, and at a comparatively small increase of cost. The additional color used is generally a neutral gray or black.

WAX ENGRAVING (THE CEROTYPE PROCESS).

The wax or cerotype process does not require finished drawings and is especially suitable for making text illustrations and small maps, although it may be used also for large work. For this process blue prints, pencil sketches, old prints, or rough copy of any kind may be submitted—that is, it is not necessary to furnish carefully prepared drawings in black ink, as it would be for photo-engraving, for the wax engraver will reproduce in proper form any illustration in which the copy and the instructions show what is wanted, just as an experienced draftsman will make a good drawing from the rough original furnished by an author. Full and clear instructions should always be given, however, as to the size of the cut wanted and what it is to show.

In this process a polished copper plate is coated with a film consisting of beeswax, a whitening medium, and other ingredients, and the coating, which varies in thickness according to the nature of the copy, is sensitized as in the ordinary photographic processes. The map or other design to be engraved is first photographed to publication size and a contact print is made on the wax coating from the negative. The lines and other parts of the photographed image are then traced or cut through the wax to the copper plate with steel tools and straightened or perfected by the engraver, but the lettering is set in printer's type, which is pressed into the wax until it also touches the metal plate. After the work of cutting through the wax has been completed the larger open spaces between the lines are "built up" by the addition of wax to give greater depth to the plate,

so that the wax plate thus built up corresponds to an electrotype mold. The plate is then dusted with powdered graphite and suspended in a solution containing copper, where by electrolytic action a copper shell is formed over its surface. When this shell is sufficiently thick it is removed from the solution and reinforced on the back with metal, and proofs are taken from it. If the proofs are satisfactory the plate is blocked type-high.

Wax-engraved plates may be used for printing colored maps or diagrams, in which variations of tint are produced by various kinds of machine rulings. The effect of some of the colors thus produced is almost a "flat" tint, in which a pattern can be detected only by close scrutiny. Some color work is printed from a wax base plate in combination with half-tone color plates.

The price of a wax engraving depends entirely on the size of the cut, the amount of work involved, and the character of the original copy, but it should not exceed very much the cost of a carefully prepared pen drawing plus the cost of a zinc etching made from it. Cuts engraved by the wax process, like zinc and half-tone plates, are delivered to the purchaser. A wax engraving gives sharper lines than a zinc etching.

WOOD ENGRAVING.

Wood engraving was once the universal method of producing cuts for illustrations that were designed to be printed on an ordinary press. It is said to be the oldest of all methods of engraving illustrations. The engraving is made on a block of boxwood, a very dense, hard wood of a light-yellow color. The block is cut type-high across the grain, and the engraving surface is made perfectly smooth by rubbing it with pumice or other stone. When a cut is to be larger than 3 or 4 inches square the wood block is made up of pieces securely dovetailed or joined together to prevent splitting and warping. A woodcut is not used for printing but is electrotyped and the electrotype is used in the press.

Originally the smoothed surface of the wood block was coated with prepared chalk or Chinese white, and on this coating a finished drawing was made with a brush and pencil by an illustrator. According to more recent practice the surface of the wood is covered with a sensitized coating, on which the drawing or design to be engraved is photographed. The engraver then, with various kinds of gravers and other tools, cuts out the parts of the picture that are to be represented by white paper and leaves the lines, dots, and black areas as a printing surface, thus translating the shades and tints of the picture into a system of lines and dots which exactly duplicate, in effect, the details and tones of the original design. In order to produce a

line effect of an area in which the tone is intermediate between white and black the engraver must space his lines so that one-half the area will remain as printing surface and the other half as white spaces, and he must give character and direction to his lines, so that, if he is skillful, he can reproduce not only the delicate tones but the texture and details of the original picture. Many wood engravers became noted for their artistic rendering of magazine illustrations, of famous paintings, and of other works of art.

The Survey began to abandon this method of engraving in 1884, when the Sixth Annual Report was in press, substituting for it the cheaper photo-mechanical processes, zinc etching and half-tone engraving, and entirely abandoned its use in 1892.

Many good examples of wood engraving may be found in the early monographs and annual reports of the Geological Survey. Monograph 2 contains numerous examples.

PHOTOGELATIN PROCESSES.

Bichromatized gelatin is used in several photomechanical processes of reproducing illustrations, but in the photogelatin processes the gelatin not only receives the image by exposure to light through a negative but becomes a printing surface on a plate from which prints are made somewhat as in lithography. The several photogelatin processes are much the same as the original collotype process and are best known by the names collotype, heliotype, albertype, artotype, and the German name lichtdruck.

In working these processes a thick plate of glass, after certain preliminary treatment, is coated with sensitized gelatin. The plate is then placed in a drying room or oven having a temperature of 120° F., baked until it is thoroughly dry, and allowed to cool gradually. The subject to be reproduced is then photographed in the usual manner, and unless a prism or mirror box has been used the negative is stripped and reversed in order to make the print reproduce the original in proper position. From the negative a contact print is made on the gelatin-coated plate, the parts or molecules of gelatin being hardened in proportion to the amount of light that affects them. After the contact print has been made the gelatin plate is thoroughly washed in cold water, in order to dissolve and wash out the bichromate and stop any further action of light on the plate, and is then thoroughly dried. Before prints are made from the gelatin-coated plate water is flowed on it and penetrates different parts of the gelatin according to their hardness. The darkest parts of the picture will correspond to the hardest and densest parts of the gelatin, which will not absorb water; the lighter parts will take up more water. The surface water is then removed with a rubber straight edge

and an absorbent roller and the plate is ready for inking. The ink, being greasy, has no affinity for water, and when it is rolled over the plate it adheres only to the dry parts of the gelatin, and in the press is carried to the paper in all the lights and shades of the illustration. The plate is kept moist in printing.

The paper used for printing from photogelatin plates must be free from chemicals that will affect the gelatin. A nearly pure rag paper is generally used.

The photogelatin process is well adapted to the reproduction of paleontologic drawings, wash drawings, photographs, photomicrographs, works of art, old manuscripts—in fact, any kind of subject in which the reproduction of delicate lights and shades is essential. If properly manipulated it has distinct advantages over the half-tone process in that it can reproduce details and light and shade without showing the effect of a screen and without the use of coated paper. Excellent reproductions by the heliotype process are also made in color by first printing the design in a neutral tone and superposing appropriate transparent colors on this print, somewhat as in chromolithography, so that the colors softly blend with the shaded groundwork.

Reproductions made by the photogelatin process are more expensive than those made by the half-tone process, for the prints are generally made on better paper and are printed with greater care. They give no screen effect and are perhaps unrivaled by prints obtained by any other process except photogravure, in which the image is printed from a metal plate that has been sensitized, exposed under a reversed negative, and etched.

Changes can not be made on photogelatin plates except by making over the corrected parts. All retouching must be done on the originals or on the negatives made from them.

LITHOGRAPHY.

ORIGINAL PROCESS.

The general term "lithography" is sometimes used to indicate not only the original process so named, said to have been invented by Senefelder, but chromolithography, photolithography, and engraving on stone, as well as engraving on copper as a means of supplying matter to be transferred to and printed from a lithographic stone.

Senefelder discovered that limestone will absorb either grease or water, and that neither one will penetrate a part of the surface previously affected by the other. He found that if a design is drawn on limestone with a greasy crayon and the stone afterward properly prepared with a solution of nitric acid and gum, greasy ink will

adhere only to the parts that are covered with the crayon, and that the stone will give off an impression of the design.

Lithographic stone is described as a fine, compact, homogeneous limestone, which may be either a pure carbonate of lime or dolomitic—that is, it may contain magnesium. Although limestone is one of the most common rocks, limestone of a quality suitable for use in lithography is found at only a few localities.[12] There are two general classes of lithographic stone, known to the trade as "blue" or hard stone and "yellow" or soft stone. The blue stone is adapted for engraving and to the better grade of fine-line printing; the yellow stone is rated as somewhat inferior.

In the original process, which may here be termed plain lithography, two methods are employed in putting on stone the design to be reproduced. In one the subject or picture to be reproduced is drawn on the printing stone either with a lithographic crayon or with a pen dipped in lithographic ink or "tusche," which is oily or fatty, like the crayon. In the other method the drawing is made on transfer paper and transferred to the stone. In drawing on stone it is necessary to reverse the design, so that all lettering must be drawn backward. In doing this the artist often uses a mirror to aid him. If the drawing is made on transfer paper the design and the lettering are copied as in the original—not reversed.

Before a drawing is made on stone a stone of the quality suited to the particular design in hand is selected. The stone is then ground and polished, and if the drawing is to be made with crayon it is "grained" according to the special requirements of the subject. If the drawing is to be made with a pen and is to consist of "line work" the stone is polished. The first step is to obtain on the stone an outline or "faint" of the design. There are several ways to do this. By one method a tracing of the design is made, a sheet of thin paper covered with red chalk is laid face downward on the stone, the tracing is laid face downward over it, and the design is again traced in red-chalk lines on the stone. The method described is simple, but there are others that are more complicated and that are particularly applicable to the reproduction of photographs and other illustrations. Crayon work is often used in combination with pen and ink, stipple, and brush work. This method of drawing on stone is used also for preparing color stones in the process of chromolithography, in which there are many added details of manipulation. After the drawing has been made on the stone or transferred to it the stone is "gummed"—that is, it is covered with a solution of gum arabic and nitric acid—and dried. The stone is then dampened with water and carefully rolled with lithographic ink, which ad-

[12] Kubel, S. J., Lithographic stone: U. S. Geol. Survey Mineral Resources, 1900, pp. 869–873, 1901.

heres to the pen or crayon work and is repelled elsewhere. It is then "rubbed" over with powdered rosin and talcum, which adheres to the ink and further protects the drawing from the effects of the etching fluid, which is next to be applied to the stone. This fluid consists of a 10 per cent solution of gum arabic to which 2 to 7 per cent of nitric acid has been added, the degree of acidity being varied according to the subject and the hardness of the stone. The fluid is applied with a brush or sponge and is left on the stone just long enough to decompose slightly the carbonate of lime on its surface and, after washing, to leave the design or drawing in very slight relief. The stone is again gummed and dried, and the design is "washed out" or brought out by removing the surface gum with a wet sponge and applying to the stone a rag sprinkled with turpentine and charged with printing ink. These operations wash away the tusche and the crayon that have been decomposed by the acid and expose the design faintly in white at first, but it gradually grows darker as it becomes charged with printing ink from the rag. The stone is next "rolled up" or inked. The slightly moistened surface repels the ink and the design takes it up, so that when the stone is run through the press the design is carried to the paper.

Lithographic prints from stones prepared in this way are made on a flat-bed press. The stone is carried forward to print and on its return is dampened and inked, an operation slower than that of rotary printing.

Corrections and changes are made on the stone by carefully scraping or polishing away the parts to be corrected and making the changes with a crayon or pen, but the design can not ordinarily be corrected twice in the same place, as the scraping or polishing removes a part of the surface of the stone and thus lessens the pressure at that place, and the impression there may be imperfect or may completely fail.

This form of lithography is seldom used for Survey illustrations but was formerly much used and is well adapted to the reproduction of drawings of fossils, particularly of remains of dinosaurs and other types of large extinct animals. Examples may be seen in Monographs 8 and 10 and in other early reports of the Geological Survey. The drawings for these illustrations were made directly on stone.

A drawing made on one stone may be transferred in duplicate or in any desired number to another stone, or to a properly grained sheet of zinc and aluminum, from which impressions may be printed on a lithographic press. Both these metals are also used for lithographic printing on rotary presses, the zinc or aluminum plate being bent and secured around a cylinder which rotates continuously in one direction. As one impression is made at each revolution of the

cylinder the printing is rapid; but the best printing from a metal plate is inferior to the best printing from a lithographic stone.

PHOTOLITHOGRAPHY.

Photolithography, like other lithographic processes, has been improved greatly during the last few years—not particularly in results but in methods—by the introduction of metal plates, the rubber blanket offset, the Ben Day films, and many mechanical and chemical devices, so that a brief description of it will not explain the process except in a most general way. As photolithography is a direct process and is relatively cheap it is the one most used for reproducing large maps and other line drawings that have been carefully prepared. Zinc and aluminum plates are now much used in photolithography, for a direct contact photographic print can be made on them, they can be printed flat or bent for use on a rotary press, and they can be stored for future use more economically than stones.

There are two somewhat distinct methods of producing photolithographs. In both the ordinary photographic methods are used, but it is often necessary to "cut" or trace parts of the negative in order to open up lines and other features that are not sharp or well defined, so that the negative will print them sharp and clear. If the copy to be reproduced shows three colors, three negatives are made, one for each color, and the parts to be shown by each are preserved by "opaquing" or painting out all other parts. By the older method the negative thus perfected is placed in a printing frame in contact, under pressure, with sensitized transfer paper and is exposed to light. The printing frame is then carried to the dark room and the paper is removed from the frame and its surface covered with transfer ink. The paper is then laid face upward on water and soaked for several minutes, after which it is placed in the same position upon a slab of stone or metal and thoroughly washed with water. This washing removes the ink and the sensitive film from the parts that were unaffected by the action of light (the parts corresponding to the white paper in the design), but the ink still adheres to the lines of the design in the precise sharpness and clearness of the negative. The design is now ready to be transferred to the printing stone or zinc plate. The sheet is again slightly dampened between moist blotters and laid face downward in its correct position on a prepared stone or zinc plate, which is then pulled through a press under heavy pressure. The paper is then removed from the stone or plate, to which it has carried the design. From this point the gumming, etching, and other operations are practically the same as those used in ordinary lithography.

The bichromate-gelatin transfer process described above has been replaced in the Survey by a more satisfactory one, which insures absolute scale and reproduces the finest line drawings perfectly without thickening the lines or without distortion. In this process, which is known as the planographic process, a photographic negative of the "copy" is placed in a vacuum printing frame in contact with a zinc or aluminum plate that has been sensitized with a bichromate-albumen solution and exposed in front of an arc lamp. After proper exposure the plate is removed from the frame, inked over, and placed under water. The parts not hardened by the action of light (the unexposed parts) are then rubbed away with cotton, and the plate is chemically etched, gummed over, and dried. The plate is then ready to be printed from in a lithographic press. If a large map is to be reproduced it is photographed in parts, and contact prints are made on zinc plates. From these plates transfers are pulled and the parts are assembled and laid down in proper position on a stone or an aluminum plate, which is then prepared for printing.

A drawing that is to be reproduced by photolithography should be made on pure-white paper in lines, dots, or black masses with black waterproof ink. It should be one and one-half to two or three times the size of the finished print.

Photolithography is particularly adapted to the reproduction of maps, plans, and other large drawings. Within certain limitations, lines may be changed and details may be added after proofs have been submitted. The process is ordinarily used for reproducing illustrations in one color (black), but it is used also for printing in more than one color, generally over a black outline base, each color being printed from a separate stone, as in chromolithography.

OFFSET PRINTING.

In the offset process the design is "offset" from a lithographic plate or stone to a rubber blanket on a cylinder, from which it is printed. By thus obtaining an impression from an elastic surface the finest details can be printed on rough, uncoated paper, which can not be used in other processes, which can be folded without danger of breaking, and which is more durable than coated paper. Plates II, III, IV, VII, and VIII in this pamphlet were printed by this process.

CHROMOLITHOGRAPHY.

The chromolithographic process, by which illustrations are printed in color from stone, is used in Survey publications principally for reproducing geologic maps, but it is sometimes used for reproducing colored drawings of specimens.

There are several kinds of color printing from stones. One produces a picture by superimposing colors that combine and overlap without definite outlines and thus reproduce the softly blended colors of the original. Another reproduces the original by printing colors within definite outlines on a "base" which has been previously printed in black. The first kind is used by the Survey for reproducing colored drawings of specimens. The second is followed in reproducing geologic maps.

As each color must be printed from a separate stone and properly fitted with respect to the others a tracing from the original is made of the precise outlines of each color; or, if the design is to be reduced, a tracing is made over a properly reduced photographic print. This tracing can be made on specially prepared tracing paper or on a sheet of transparent gelatin or celluloid, which is laid over the copy and on which all the outlines and overlaps of the various colors are scratched with a steel point. The scratches thus made on the celluloid are filled with red chalk or like substance, and rubbed in with cotton, and by reversing the sheet and rubbing it the chalk lines are deposited on as many stones as are needed to produce the colors of the original design, each stone bearing all the outlines of the design. Sometimes all the outlines are engraved on what is called a key stone and an impression from it is laid down on each of the color stones. The parts on each stone that are to have one color are then inked in or engraved, and at the same time guide marks are indicated, so that in the composite print from the stones each color will fit its proper place. This fitting is called "register" and is an important part of printing, for each stone must be adjusted to a nicety while on the press in order to make each impression fit the others exactly. The process was originally manipulated entirely by hand, but photography has now replaced much of the handwork and has given rise to several methods by which the same kinds of subjects are reproduced in radically different ways. Tints are sometimes produced by the half-tone and other screens and by machine ruling, and printer's type is used almost exclusively for titles and other matter that was formerly engraved or drawn on the stone.

In reproducing a geologic map the base may be engraved on stone or on copper or it may be photolithographed. By either process the map may be transferred to the printing stone. The color stones for geologic maps are prepared by hand, but the geologic patterns, which are printed in colors, are engraved separately on plates, from which impressions are pulled when needed and transferred to their proper places on the printing stones in the shapes required according to the "key" design. The lighter, more transparent colors are generally printed first, and often twelve or more colors and many distinctive patterns are used to produce a geologic map. When proofs

of such a map are pulled each stone must be taken up and carefully adjusted on the press, so that the work of proving maps that are printed from a considerable number of color stones is laborious and expensive. It is therefore customary to approve first combined proofs conditionally—that is, subject to the corrections and changes indicated on the proofs—and to hold the lithographer responsible for any failure to make the corrections.

This process is the most expensive one used for reproducing illustrations. Changes may be indicated on proofs, but changes can not be made on a stone twice in the same place without danger of affecting the printing or making it necessary to retransfer the parts affected. All changes are expensive because a slight modification at one point may involve corresponding changes on a number of stones, each of which must be taken up, corrected, and proved to insure the exact coincidence of the parts affected. It is often less expensive to retransfer the entire job than to make extensive changes on the original stones.

ENGRAVING ON STONE AND ON COPPER.

Engraving on stone is distinctly lithographic, but engraving on copper is sometimes included among lithographic processes because the work produced by it is usually printed from stone and thus becomes lithographic. In other respects engraving on copper is not a lithographic process. Roughly prepared maps and any rough line copy that is accurate in statement and clear as to intent are appropriate for both methods of engraving, but drawings that are expertly prepared are more suitable for reproduction by photolithography. In engraving on stone the lines of a design are scratched on the blackened surface of a stone with a steel-pointed tool; in engraving on copper the lines are cut with a graver on a sheet or plate of copper, the matter to be engraved being first shown on the plate by what is called the photo-tracing process, which was devised in the Geological Survey. There is, however, no great or essential difference in the printed results of the two processes, but most lithographers employ only stone engravers.

A stone on which a design is to be engraved is ground and polished according to the kind of work to be engraved, is coated with a thin solution of gum arabic and allowed to dry, and is then washed until the superficial gum is removed while the surface pores remain filled. As the lines made by the engraver must be visible the stone is blackened with a pigment composed of lampblack and gum or is covered evenly with red chalk or venetian red. It is then ready to receive the design to be engraved.

If the design is a map which is to show culture, streams, and surface contours, and each of these sets of features is to be printed in a

separate color, impressions of the work to be engraved must be placed on three stones. One method of doing this is to make a scratch tracing of the original drawing on a sheet of transparent gelatin or celluloid in the manner employed in chromolithography, except that a dry pigment, generally chrome-yellow, is used to fill the scratch lines instead of red chalk or venetian red. From this tracing a "faint" or imprint of all the details of the three separate features of the map is made on each of the three stones, and the engraver then cuts on each stone only the lines and other features, including ample register marks, that are to be printed in one color, the imprint made from the tracing making it possible to engrave each set of features in its exact position relative to the other two. By another method the matter to be engraved is photographed directly on the stone.

The engraving is done with a steel needle inserted in a small wooden cylinder, an instrument resembling an ordinary lead pencil. The size and shape of the needles used are varied according to the requirements of the matter to be engraved. With this instrument the lines and lettering are lightly scratched into the stone through the dark coating and show as light lines. The points of some of the needles are fine; those of others are V-shaped; and some have spoon-shaped points, for use in thickening lines and shading letters. All features are engraved in reverse.

After the engraving is completed the stones are prepared for printing by wiping off all the superficial color and filling the engraved lines with a greasy ink—generally a thin printing ink—which is rubbed into the lines with a soft rag. Impressions are then pulled on transfer paper and transferred to three printing stones for use in printing the three colors, the register marks enabling the pressman to fit each color exactly in its proper place.

In all lithographic processes the titles and other marginal lettering can be and usually are transferred from type impressions to the printing stones. It is therefore unnecessary to letter such matter carefully on an original drawing that is made for lithographic reproduction, for appropriate faces of type will give better printed results than hand lettering.

Corrections can not be made on a stone or copper engraving as readily as on a drawing. If a stone engraver makes an error or if a change is required after his engraving is finished, the parts to be corrected must be scraped off and a new ground laid before the correction can be made. Sometimes he will engrave the parts corrected on another part of the original stone and transfer it to the printing stone. Corrections are made on copper plates by "hammering up" the plate from beneath, polishing off a new surface, and reengraving the part to be corrected.

APPENDIX.

The matter given in this appendix is much used in making geologic maps and other illustrations. The Greek alphabet and the groups of signs presented are given chiefly to show the correct formation of each letter and sign.

MISCELLANEOUS TABLES.

Length of 1° of longitude measured along given parallels from the Equator to the poles.

[From U. S. Coast and Geodetic Survey Report for 1884, Appendix 6.]

Parallel of latitude.	Statute miles.	Parallel of latitude.	Statute miles.	Parallel of latitude.	Statute miles.
0	69.172	31	59.365	61	33.623
1	69.162	32	58.716	62	32.560
2	69.130	33	58.071	63	31.488
3	69.078	34	57.407	64	30.406
4	69.005	35	56.725	65	29.315
5	68.911	36	56.027	66	28.215
6	68.795	37	55.311	67	27.106
7	68.660	38	54.579	68	25.988
8	68.504	39	53.829	69	24.862
9	68.326	40	53.063	70	23.729
10	68.129	41	52.281	71	22.589
11	67.910	42	51.483	72	21.441
12	67.670	43	50.669	73	20.287
13	67.410	44	49.840	74	19.127
14	67.131	45	48.995	75	17.960
15	66.830	46	48.136	76	16.788
16	66.510	47	47.261	77	15.611
17	66.169	48	46.372	78	14.428
18	65.808	49	45.469	79	13.242
19	65.427	50	44.552	80	12.051
20	65.026	51	43.621	81	10.857
21	64.606	52	42.676	82	9.659
22	64.166	53	41.719	83	8.458
23	63.706	54	40.749	84	7.255
24	63.228	55	39.766	85	6.049
25	62.729	56	38.771	86	4.842
26	62.212	57	37.764	87	3.632
27	61.676	58	36.745	88	2.422
28	61.122	59	35.716	89	1.211
29	60.548	60	34.674	90	.000
30	59.956				

Length of 1° of latitude measured along a meridian at given parallels.

[Parallel given is in center of the degree whose length is stated.]

Parallel of latitude.	Statute miles.	Parallel of latitude.	Statute miles.
0	68.704	50	69.115
10	68.725	60	69.230
20	68.786	70	69.324
30	68.879	80	69.386
40	68.993	90	69.407

Metric system and equivalents.

[The units of linear measure most commonly used are millimeters (mm.), centimeters (cm.), decimeters (dm.), meters (m.), and kilometers (km.). 1 m.=10 dm.; 1 dm.=10 cm.; 1 cm.=10 mm.; 1 km.=1,000 meters=0.62137 mile; 1 m.=39.37 inches=3.280833 feet.]

Meters.	Inches.	Meters.	Feet.	Kilometers.	Miles.
1	39.37	1	3.280833	1	0.62137
2	78.74	2	6.561667	2	1.24274
3	118.11	3	9.842500	3	1.86411
4	157.48	4	13.123333	4	2.48548
5	196.85	5	16.404166	5	3.10685
6	236.22	6	19.685000	6	3.72822
7	275.59	7	22.965833	7	4.34959
8	314.96	8	26.246666	8	4.97096
9	354.33	9	29.527500	9	5.59233

Inches.	Centimeters.	Feet.	Meters.	Miles.	Kilometers.
1	2.54	1	0.304801	1	1.60935
2	5.08	2	0.609601	2	3.21869
3	7.62	3	0.914402	3	4.82804
4	10.16	4	1.219202	4	6.43739
5	12.70	5	1.524003	5	8.04674
6	15.24	6	1.828804	6	9.65608
7	17.78	7	2.133604	7	11.26543
8	20.32	8	2.438405	8	12.87478
9	22.86	9	2.743205	9	14.48412

The "vara," used in Texas, is equivalent to 33⅓ inches and is computed as representing 2.78 feet.

Geologic eras, periods, systems, epochs, and series.

Era.	Period or system.	Epoch or series.
Cenozoic	Quaternary	Recent. Pleistocene (replaces "Glacial").
	Tertiary	Pliocene. Miocene. Oligocene. Eocene.
Mesozoic	Cretaceous	Upper (Gulf may be used provincially). Lower (Comanche and Shasta may be used provincially).
	Jurassic	Upper. Middle. Lower.
	Triassic	Upper. Middle. Lower.
Paleozoic	Carboniferous	Permian. Pennsylvanian (replaces "Upper Carboniferous"). Mississippian (replaces "Lower Carboniferous").
	Devonian	Upper. Middle. Lower.
	Silurian.	
	Ordovician	Upper (Cincinnatian may be used provincially). Middle (Mohawkian may be used provincially). Lower.
	Cambrian	Saratogan (or Upper Cambrian). Acadian (or Middle Cambrian). Waucoban (or Lower Cambrian).
Proterozoic	Algonkian.. Archean....	pre-Cambrian.

Chemical elements and symbols.

Element.	Symbol.	Element.	Symbol.	Element.	Symbol.
Aluminum	Al	Holmium	Ho	Rhodium	Rh
Antimony	Sb	Hydrogen	H	Rubidium	Rb
Argon	A	Indium	In	Ruthenium	Ru
Arsenic	As	Iodine	I	Samarium	Sa
Barium	Ba	Iridium	Ir	Scandium	Sc
Bismuth	Bi	Iron	Fe	Selenium	Se
Boron	B	Krypton	Kr	Silicon	Si
Bromine	Br	Lanthanum	La	Silver	Ag
Cadmium	Cd	Lead	Pb	Sodium	Na
Cæsium	Cs	Lithium	Li	Strontium	Sr
Calcium	Ca	Lutecium	Lu	Sulphur	S
Carbon	C	Magnesium	Mg	Tantalum	Ta
Cerium	Ce	Manganese	Mn	Tellurium	Te
Chlorine	Cl	Mercury	Hg	Terbium	Tb
Chromium	Cr	Molybdenum	Mo	Thallium	Tl
Cobalt	Co	Neodymium	Nd	Thorium	Th
Columbium	Cb	Neon	Ne	Thulium	Tm
Copper	Cu	Nickel	Ni	Tin	Sn
Dysprosium	Dy	Niton	Nt	Titanium	Ti
Erbium	Er	Nitrogen	N	Tungsten	W
Europium	Eu	Osmium	Os	Uranium	U
Fluorine	F	Oxygen	O	Vanadium	V
Gadolinium	Gd	Palladium	Pd	Xenon	Xe
Gallium	Ga	Phosphorus	P	Ytterbium (Neoytterbium)	Yb
Germanium	Ge	Platinum	Pt	Yttrium	Y
Glucinum	Gl	Potassium	K	Zinc	Zn
Gold	Au	Praseodymium	Pr	Zirconium	Zr
Helium	He	Radium	Ra		

Greek alphabet.

Caps.	Lower-case.	Greek name.	English sound.	Caps.	Lower-case.	Greek name.	English sound.
A	α	Alpha.	A.	N	ν	Nu.	N.
B	β $\mathit{6}$	Beta.	B.	Ξ	ξ	Xi.	X.
Γ	γ	Gamma.	G.	O	o	Omicron.	O short.
Δ	δ	Delta.	D.	Π	π ϖ	Pi.	P.
E	ϵ	Epsilon.	E short.	P	ρ	Rho.	R.
Z	ζ	Zeta.	Z.	Σ	ς σ	Sigma.	S.
H	η	Eta.	E long.	T	τ	Tau.	T.
Θ	θ ϑ	Theta.	Th.	Υ	υ	Upsilon.	U.
I	ι	Iota.	I.	Φ	ϕ φ	Phi.	F.
K	κ	Kappa.	K.	X	χ	Chi.	Ch.
Λ	λ	Lambda.	L.	Ψ	ψ s	Psi.	Ps.
M	μ	Mu.	M.	Ω	ω	Omega.	O long.

Roman numerals.

I	1	IX	9	LXX	70	D	500
II	2	X	10	LXXX	80	DC	600
III	3	XIX	19	XC	90	DCC	700
IV	4	XX	20	C	100	DCCC	800
V	5	XXX	30	CL	150	CM	900
VI	6	XL	40	CC	200	M	1000
VII	7	L	50	CCC	300	MD	1500
VIII	8	LX	60	CD	400	MCM	1900

Mathematical signs.

+ plus.
− minus.
× multiplied by.
÷ divided by.
= equality.
± plus or minus.
□ square.
▭ rectangle.
△ triangle.
○ circle.
∠ angle.
∟ right angle.
⊏ or > greater than.
⊐ or < less than.
⊥ perpendicular.
∼ difference
$\int$ integration.
⧟ equivalence.
: ratio.
∺ geometrical proportion.
−: difference, excess.
∴ therefore.
∵ because.
∞ infinity.
∝ varies as.
√ radical.
° degree.
′ minute.
″ second.

NAMES OF ROCKS.

The following list was prepared in the geologic branch for the use of geologic draftsmen to enable them to select appropriate symbols for rocks that may be referred to in preliminary drawings by name only. For sedimentary rocks dots and circles, parallel lines, and broken or dotted lines are used; for metamorphic rocks short dashes arranged without definite patterns; and for igneous rocks patterns composed of short dashes, triangles, rhombs, crosses, and cross lines. All these patterns are shown in Plate III.

Sedimentary material.

[Including residual, detrital, eolian, glacial, organic, and chemically precipitated material.]

Agglomerate.
Alabaster.
Alluvium.
Alum shale.
Anhydrite.
Apron (alluvial).
Argillite.
Arkose.
Asphalt.
Bench gravel.
Bentonite.
Boulder clay.
Brea.
Breccia.
Brownstone.
Burrstone.
Calcarenite.
Calc sinter.
Caliche.
Catlinite.
Chalk.
Chert.
Clay.
Coal.
Conglomerate.
Coprolite.
Coquina.
Detritus.
Diatomaceous earth.
Diluvium.
Dolomite.
Drift.
Fan (alluvial).
Fanglomerate.
Flagstone.
Flint.
Freestone.
Fuller's earth.
Geyserite.
Gravel.
Graywacke.
Greensand.
Grit.
Gumbo.
Gypsum.
Hardpan.
Hematite.
Infusorial earth.
Ironstone (also igneous).
Itacolumite.
Kame.
Kaolin.
Laterite.
Lignite.
Limestone.
Limonite.
Loess.
Marble (also metamorphic).
Marl.
Metaxite.
Morainal deposit.
Mudstone.
Novaculite.
Peat.
Pelite.
Phosphate rock.
Phosphorite.
Phthanite.
Psammites.
Psephites.
Puddingstone.
Pyroclastic material.
Quartzite (also metamorphic).
Reddle.
Rock salt.
Rock stream.
Rubble.
Salt.
Sand.

Sedimentary material—Continued.

Sandstone.
Selenite.
Shale.
Silt.
Slate (also metamorphic).
Soil.
Stalactite.
Stalagmite.
Talc.
Talus.
Till.
Travertine.
Tripoli.
Tufa (=chemically deposited lime).
Tuff (=igneous fragments).
Wacke.
Wash.

Metamorphic material.

Adinole.
Amphibolite.
Andalusite schist (?).
Apo (rhyolite), etc.
Argillite.
Augen gneiss (also igneous).
Biotite schist.
Calc schist.
Cataclastic.
Chlorite schist.
Clay slate.
Damourite schist.
Desmosite.
Dynamometamorphic rock.
Eclogite.
Epidosite.
Erlan.
Erlanfels.
Eulysite.
Fibrolite schist.
Garnet rock.
Garnet schist.
Gneiss.
Granite gneiss.
Graywacke (?).
Green schists.
Greenstone (also igneous).
Greisen.
Halleflinta.
Hornblende schist.
Hornfels.
Hornstone.
Itabirite.
Kinzigite.
Knotenschiefer.
Knotty schists.
Luxulianite (igneous?).
Marble.
Meta (diabase), etc.
Mica schist.
Mylonite.
Ophicalcite.
Ottrelite schist.
Phyllite.
Porcelanite.
Protogene.
Pyroschists.
Quartz.
Quartzite.
Quartz schist.
Schist.
Sericite schist, etc.
Serpentine.
Slate.
Soapstone.
Sodalite.
Spilosite.
Steatite.
Talc schist.
Topazfels.
Topaz rock.
Zobtenite.

Igneous material.

Absarokite.
Abyssal.
Adamellite.
Adendiorite.
Ailsyte.
Åkerite.
Alaskite.
Albitite.
Allivalite.
Allochetite.
Alnöite.
Alsbachite.
Ambonite.
Amherstite.
Analcitite.
Andesite.
Anorthosite.
Aphanitite.
Aplite.
Arkite.
Atatschite.
Augen gneiss (also metamorphic).
Augitite.
Avezacite.
Banakite.
Banatite.
Bandaite.
Basalt.
Basanite.
Beerbachite.
Bekinkinite.
Bombs.
Borolanite.
Bostonite.
Camptonite.
Carmeloite.
Cascadite.
Chibinite.
Ciminite.
Comendite.
Complementary rocks.
Coppaelite.
Cortlandite.
Cromaltite.
Cumberlandite.
Cuselite.
Dacite.
Dellenite.
Diabase.
Diallagite.
Dike rock.
Diorite.
Ditroite.

Igneous material—Continued.

Dolerite.
Dunite.
Durbachite.
Effusive rock.
Ekerite.
Elvan.
Enstatite.
Eruptive rock.
Essexite.
Estrellite.
Eulysite.
Extrusive rock.
Farrisite.
Felsite.
Felsophyre.
Fergusite.
Fortunite.
Fourchite.
Foyaite.
Gabbro.
Gauteite.
Garewaite.
Giumarrite.
Gladkaite.
Granite.
Granitite.
Granitoid.
Granodiorite.
Granophyre.
Greenstone (also metamorphic).
Greisen?
Grorudite.
Harrisite.
Harzburgite.
Haüynophyre.
Hawaiite.
Hedrumite.
Heumite.
Holyokeite.
Hornblendite.
Hypabyssal rock.
Hyperite.
Hypersthenite.
Ijolite.
Intrusive rock.
Irruptive (=intrusive) rock.
Isenite.
Jacupirangite.
Jumillite.
Kaiwekite.
Kedabekite.
Kentallenite.
Kenyite.
Keratophyre.
Kersantite.
Kimberlite.
Kohalaite.
Krablite.
Krageröite.
Kulaite.
Kyschytymite.
Lamprophyre.
Latite.
Laugenite.
Laurdalite.
Laurvikite.
Lava.
Lestiwarite.
Leucite basalt.
Leucite tephrite.
Leucitite.
Leucocratic.
Lherzolite.
Limbergite.
Lindoite.
Liparite.
Litchfieldite.
Lithoidite.
Luciites.
Lujaurite.
Madrupite.
Maenaite.
Magma basalt.
Malchite.
Malignite.
Mangerite.
Mariupolite.
Melaphyre.
Melilite basalt.
Mesanite.
Mica peridotite.
Minette.
Missourite.
Monchiquite.
Mondholdeite.
Monmouthite.
Monzonite.
Mugearite.
Naujaite.
Nelsonite.
Nephelinite.
Nevadite.
Nordmarkite.
Norite.
Obsidian.
Odinite.
Orbite.
Orendite.
Ornöite.
Orthophyre.
Ortlerite.
Ouachitite.
Paisanite.
Pantellerite.
Pegmatite.
Peridotite.
Perknite.
Perlite.
Phanerite.
Phonolite.
Pierite.
Pitchstone.
Plagiaplite.
Plagioclastic.
Plumasite.
Plutonic rock.
Pollenite.
Porphyry.
Pulaskite.
Pumice.
Pyroxenite.
Rhombenporphyry.
Rhyolite.
Rizzonite.
Rockalite.
Santorinite.
Sanukite.
Saxonite.
Scyelite.
Shastaite.
Shonkinite.
Shoshonite.
Soda granite.
Sölvsbergite.
Sommaite.
Spessartite.
Sussexite.
Syenite.
Taimyrite.
Tawite.
Tephrite.
Teschenite.
Theralite.
Tilaite.

Igneous material—Continued.

Tinguaite.
Tjosite.
Tonalite.
Tonsbergite.
Tordrillite.
Toscanite (?).
Trachy-andesite.
Trachyte.
Trap.
Troctolite.
Umptekite.
Unakite.
Ungaite.
Urtite.
Valbellite.
Venanzite.
Verite.
Vitrophyre.
Vogesite.
Volcanic rock.
Volhynite.
Vulsinite.
Websterite.
Wehrlite.
Windsorite.
Wyomingite.
Yamaskite.

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SUGGESTIONS

BY VARIOUS HANDS

TO TYPISTS, GRITICS, AND WRITERS

GONGERNED IN THE PREPARATION OF MANUSGRIPTS

FOR THE

UNITED STATES GEOLOGICAL SURVEY

GOMPREHENDING

INSTRUGTIONS RELATING TO THE OUTWARD FORM OF

SUGH MANUSGRIPTS

WHEREUNTO IS APPENDED

AN IRONIGKAL DISQUISITION

UPON THE

PRINGIPLES OF POOR WRITING

THE WHOLE ADAPTED TO THE MEANEST GAPAGITIES

WASHINGTON
1949

FOREWORD

One of the serious continuing problems that confronts the efficient functioning of the Mineral Deposits branch is the adequate review of the manuscripts submitted to the branch chief for publication. The Geological Survey policy on the content and arrangement of such manuscripts has always been clear and definite. In the past a small group of critics and the section chief, familiar with this Survey policy, could cope with the number of manuscripts written by the geologists in the section.

Now the branch has grown to such size that it is no longer possible for the experienced critics to do all the necessary reviewing. Consequently, more and more of the reviewing of manuscripts must be delegated to the other geologists in the branch. However, our geologists are spread throughout the Nation. Normally a manuscript is submitted to the Washington office by a geologist at a field station in one state, it is examined in the manuscript-processing office in Washington, and then is sent to another geologist at another field station in another state for review. Because of the widespread distribution of the staff the informal policy of review that served so well in the past is not applicable to the present problem.

Unfortunately, a large proportion of our geologists do not have sufficient knowledge of what the Survey requires from a critic, because they have never had the opportunity to learn by their own experience or from the experience of the older Survey geologists.

This guide has been written in an attempt to provide the necessary knowledge for the less experienced critics. It is based on the wisdom of those geologists, particularly H. G. Ferguson and F. C. Calkins, who are best qualified through their experience to establish a branch policy to promote the speed and efficiency needed in processing manuscripts.

I believe that serious attention to the principles and methods set forth in this paper will do a great deal toward solving the problem of adequate review. I also believe that these principles will be helpful to the branch authors, as careful observance of them during the writing of any report will lessen the length of time needed for the processing of the report, and hence will be in the best interest of the author.

Olaf N. Rove, Chief
Mineral Deposits Branch

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PREPARATION OF MANUSCRIPTS FOR PUBLICATION

The following revision of a memorandum prepared by Chalmer L. Cooper, in charge of publications in the Director's office, applies particularly to the manuscripts submitted to the Mineral Deposits branch for the Director's approval of publication. Each one of the 12 items discussed below should be observed in the preparation of every paper, as careful attention by the author and typist to these items will materially hasten the processing of the manuscript in the branch.

After careful observation of Geological Survey practices it is evident that insufficient attention is being given to those parts of *Suggestions to Authors* which describe the essential features for correct preparation of a manuscript. Some of the more important items are mentioned below as a guide to authors and typists.

1. Copy should be typed on paper of ordinary thickness and of uniform size; thin manifold paper should not be used, and a mixture of two or more sizes must be avoided.

2. Typing should be double spaced and with adequate margins--not less than one inch at the top, bottom, and on each side.

3. If new matter is to be inserted on a page already typed, the page should be cut apart, the new copy typed on a separate sheet, and the pieces pasted together on a fresh sheet or sheets of regular size. Do not use rubber cement, scotch tape, or stapling machine. It is better to have the pages with the insertion retyped, if practicable.

4. Copy for indexes and for long bibliographies may be typed on cards of uniform size.

5. Numbering of manuscript pages should be on the bottom. (Editors do final numbering in upper right corner.) Pages added to a manuscript after it is typed should carry the number of the preceding page with a, b, c, etc., for each added page; a notation should be made on the bottom of the preceding page, e.g., "Pages 128a-c follow."

6. The manuscript should include a table of contents (headed "Contents"), with marginal identations indicating the relative rank of headings. As a rule, each heading should begin 5 letter-spaces to the right of the heading that ranks next above it. Indentations should be carefully checked to be sure that they are uniform for headings of the same rank.

7. Two lists of illustrations (headed "Illustrations") should be prepared. The "short" list, to be printed in the report, consists of brief titles, given mainly to show the general subject of each illustration and its place in the book. The "long" list should give full titles, including any descriptive matter that is to appear on the plates. Two copies of each list should be furnished--original and carbon. Every list should carry, for each illustration, the number of the manuscript page on which the principal reference to that illustration is made.

For each text figure, the number and full title should be typed in the manuscript at the place where the principal reference appears, with a one-line space above and below, and further separated from the text by a short line (about one inch long) above and below, at the extreme left edge of the text.

8. Center headings should be typed in caps and lower case, and not underlined. Side headings are on the regular paragraph indention (5 spaces), typed in caps and lower case, underlined, followed by a period and two hyphens, with text run in.

9. Footnotes should *not* be numbered by typist or author, but a shelf (_/) should be typed in the text and on the footnote, for later insertion of the number. Each footnote should be typed, double space, immediately below the line in which the reference appears and separated from the text by a short line (about one inch long) above and below, at the extreme left edge of text.

Literature references in large manuscripts may be listed together in alphabetical order following the text, in order to avoid unnecessary repetition of the reference in footnotes or excessive use of idem and op. cit. Such a list also eliminates the necessity of a separate bibliography. In the text, reference is made to this list by author, date, and page, "Smith (1925, p. 110) states that this feature is characteristic..." References may be typed on 3 by 5 cards to facilitate alphabetizing.

References should rigidly follow the style given in *Suggestions to Authors* and should contain *all* pertinent data, as follows:

(a) Author's name (with initials or given name, if only one)
(b) Title of article or book, in full (no abbreviations)
(c) Name of series, periodical, or publisher (follow abbreviations given in "*Suggestions*," pp. 20-29)
(d) Volume and number
(e) Page reference
(f) Figure and plate number, if needed
(g) Date of issue (year)

If any of the above items are incomplete or missing, the author or the typist should should leave space for the insertion of the missing data.

Over abbreviation of literature references to the point of unintelligibility should be avoided. (See *Suggestions to Authors*, pp. 19-29, for further details.)

10. Each table should be typed on a separate page; do not type text and tabular matter on the same sheet. Copy for tables should not be crowded. When necessary, oversized sheets (preferably two or four times manuscript size) should be used.

Presentation of tabulated information in a concise and orderly manner and in suitable form for printing presents many difficulties. For many publications this information can be arranged in a form that is used again and again, so the preparation of printer's copy presents little difficulty. However, many tables are of special character, and these require careful planning on the part of author and typist in order to get the most usable and economical arrangement. Careful preliminary planning and close attention to the details presented in *Suggestions* and the Government Printing Office *Style Manual* will greatly facilitate the work of those who later handle the manuscript. It is often helpful to examine tables in a printed report similar to the one being typed, for details of style and composition.

Field sheets or printed forms containing tabular data that have been extensively altered or emended should not be submitted as copy for the printer but should be retyped in exactly the style desired.

A table may require more than one sheet, in which case the title should be repeated and followed by "--Continued." Head notes need not be repeated.

11. Technical reviewers should confine their markings on the manuscript to recommended changes in text. Discussion of debatable questions should not be written on the margin of the manuscript but given on a separate sheet.

12. When the manuscript is transmitted it should be kept flat and securely tied. All letters of transmittal, together with all endorsements of approval, reviewer's comments, etc., should be kept intact with the manuscript. Markings on the manuscript must not be erased. Copy for all illustrations should accompany manuscript.

January 28, 1947
Reprinted: January 1949

SUGGESTIONS TO CRITICS

INTRODUCTION

The following information is based chiefly on a memorandum prepared in the spring of 1948 by H. G. Ferguson. This memorandum was reviewed by F. C. Calkins, R. S. Cannon, H. E. Hawkes, E. T. McKnight, and T. P. Thayer, all of whom wrote comments and suggestions for possible improvements. Ferguson then wrote comments on these comments. J. H. Eric, who had been helping process reports for the branch, then combined the original draft, the comments, and the comments on comments. R. E. Van Alstine and J. B. Hanley reviewed the manuscript and made some additional suggestions.

The following section is included as a background for those critics who, for one reason or another, are not familiar with the process of "getting a paper through the mill".

A manuscript written by a geologist in the Mineral Deposits branch is generally transmitted to the branch chief, who sends it to his representative in charge of the manuscript-processing unit of the branch. The report is briefly examined, the pertinent data are carded, and a routing sheet (copy attached) is filled out. This sheet will accompany the report through the mill, and on it are recorded the signatures of all who have seen the report together with the dates each received and forwarded it. Then the representative selects a critic. The critic is generally, though not always, another geologist in the branch who is familiar with the area or commodity with which the report deals. Sometimes the report has already been reviewed or the author suggests one or two critics; his suggestion is followed whenever practicable.

When the critic has completed his review, he signs the routing sheet and returns the report, together with his comments, to the manuscript-processing unit. There the report again is examined briefly, after which it is returned to the author with the suggestion that he consider the comments of the critic and adopt any that he deems advisable. After the author has studied the comments and has made such revisions as he believes necessary, he signs the routing sheet, and returns the report to the Branch.

GEOLOGIC BRANCH

Routing sheet for all manuscripts

Author .....

Title .....

.....

Submitted for approval for publication as (or in).....

.....

This manuscript (with accompanying maps and illustrations) has been reviewed, revised, edited or recommended for approval by:

	Name	Date rec'd	Date forwarded
1) Technical critic and reviewer	.....	.....	.....
2) Author (revision)	.....	.....	.....
3) Branch Chief	.....	.....	.....
4) Division Chief	.....	.....	.....
5) Office Geol. Inf. & Reports (a) Mss. Review	.....	.....	.....
(b) Geol. Names	.....	.....	.....
6) Originating section (Author clearance, retyping, etc.)	.....	.....	.....
7) Office Geol. Inf. & Reports	.....	.....	.....
8) Chief Geologist	.....	.....	.....
9) Approved for publication, by Director:			
10) (a) Section of Texts (Regular publications) or	.....	.....	.....
(b) Office of Geol. Inf. & Reports (all offset and mimeo jobs, with attached requisitions) or	.....	.....	.....
(c) To author for transmittal (if for outside publication)			
11) Office of Geol. Inf. & Reports: (a) Geol. Map Editor	.....	.....	.....
(b) Section of Cartography	.....	.....	.....

The report is again sampled by the manuscript-processing unit, this time to see (1) that the author either has adopted the critic's suggestions, or has indicated his reasons for not accepting them, and (2) that the report fulfills the 11 requirements listed on the Branch Chief's check list (copy attached). If the report seems to be in good shape, the text is retyped if necessary and the illustrations are sent to the section of Geologic Cartography for any necessary corrections of the drafting. Upon completion of the clean copy of both text and illustrations the head of the manuscript-processing unit signs the routing sheet for the branch chief. This means that the report is now considered to be in sufficiently good condition so that it can be sent forward from the branch, for further processing, and, finally, the Director's approval. Carbon copies cannot be sent out of the branch for further processing.

GENERAL PURPOSE OF REVIEW

The main objectives of the review are (1) to suggest changes that will improve the paper, (2) to give hints to the author that will enable him to do better next time, and (3) to help the author avoid pitfalls or inadvertencies of possible serious consequence either to himself or to the Survey. The critic should not even appear to be acting as a censor, handing down arbitrary do's or dont's as to either content or form. He should give his reasons for suggesting changes, and should leave the author as free to express himself in his own way as is consistent with clarity, effectiveness, logical arrangement, and the purpose of the paper. The meaning must be clear, and the organization such that the text is readable without undue effort on the part of the reader.

Critics should watch for blunders that may reflect on either the Survey or the author, and should check such matters as: permission to use, and proper acknowledgement of, borrowed data or conclusions; appropriate credit for data or conclusions contributed by collaborators; adequacy of references cited, in terms of professional ethics; permission of mine owners to publish maps, reserve data, or other confidential information and other implications that the report may have in reference to industrial situations, legal matters, and national or Survey policies. The author of a Survey publication is not separable from the Survey, and it would be naive for the critic to assume that the author shoulders all the responsibility for a serious blunder in a Survey or outside report.

MANUSCRIPT CHECK LIST FOR BRANCH CHIEFS

(all formal publications)

1. Manuscript has been reviewed and criticized in branch ----------
2. Revision is acceptable to author and branch ----------
3. Illustrations have been checked with text and show what text says they show ----------
4. Places referred to in text also appear on maps ----------
5. Illustrations cited are all included with MS ----------
6. Illustration numbers agree with text references ----------
7. Manuscript includes correctly worded title page ----------
8. Manuscript includes table of contents ----------
9. Manuscript includes abstract ----------
10. Manuscript includes both "short" and "long" lists of illustrations in duplicate ----------
11. Manuscript is clean and legible and is not a carbon copy ----------

Note. — Items 8, 9, and 10 may not be required for outside publication in some journals or state publications. Item 4 may be modified to exclude places that can not be shown on maps that accompany text.

MECHANICS OF REVIEW

Critics naturally will adopt their own methods, but the following method has been found to work fairly well for Survey reports. These reports include professional papers, bulletins, circulars, and material for the new geologic map series and the strategic minerals investigations preliminary map series.

First read the paper carefully without making comments, but put a light pencil (colored) mark in the margin against anything that for any reason seems to need further consideration. This will give you a good idea of the general style and the weak points. The critic should bear in mind the type of reader to whom the paper is addressed (for example, a mineral resources quickie versus a professional paper).

On the second reading, pay particular attention to the marked passages and sections, and study the illustrations with care. Do not mark the text or illustrations except to correct obvious errors. Give each passage on which you comment a key number, and write whatever comments you wish to make on a separate sheet of paper, but make certain you do not insult the author. Underline misused time adverbs, overworked clichés, and jargon with a colored pencil.

When it is necessary to mark an illustration use a 2-H or 3-H pencil; make all notations in the margins and use light leaders to tie notations to features on the map. It is undesirable to mark up any illustration except where absolutely necessary. Never use colored pencils of any shade of yellow or red for map corrections.

Go over the paper rapidly a third time with your detailed comments before you; very likely you will want to delete some, change others, and add a few.

Then write a review of the paper. Start with a paragraph or two on the report as a whole. Put the good points first (every paper has some), then the principal failings. If the paper gives evidence as to the degree of thoroughness of the field work, mention it. Critics conscious of a tendency to be over-sarcastic may find that the tendency is curbed when they put their comments on paper. In general, writing the comments will require thought and care in composition, because some authors consider written criticisms officious and a blow to the ego.

Follow this with brief comments, section by section. Point out the major changes and principal defects; give suggestions for improvement or point out that they are specified in the detailed comments. To some extent this duplicates your detailed comments (to which you have given key numbers), but may be of value to the author and possibly to his supervisor. It will be helpful if the critic states what he has and has not re-

viewed in the paper. A critic not skilled in petrography, for example, might skim through that section of a manuscript and miss some blunders. When comments are typed, put the review section first.

After due time the paper may come back to you, if you request a second look at it, with the author's comments on your comments. If it does, you need do no more than see that he has accepted them or given a fairly adequate reason why he prefers his own way. If a disagreement remains that you consider really vital, refer it to the branch chief or his representative.

DUTIES OF CRITICS

In most papers arrangement can be improved. All authors tend to be led into digressions, which should be called to their attention. If general arrangement is poor, suggest what you think is better. A tabulation of what the critic thinks is the best arrangement, accompanied by a parallel summary of the author's treatment, showing digressions, often helps. Inadequate organization, like poor focus in a camera, may produce vagueness, repetition, and confusion. For most manuscripts the Survey's standardized form is best (see *Suggestions to Authors* and examples of Survey publications), but it should not be a strait jacket. Watch subheads particularly and see that they cover what they advertise.

Call attention to major lapses into poor expression, but don't try to be an Editor with a capital E; the paper will receive later editorial revision in the section of texts. If you think the author leaves an entirely different impression from what you believe he meant to say, try to suggest an alternative expression and tell him why you are doing so. The place to get such difficulties ironed out is in the earliest reviews; the less a final editor has to do to a manuscript, the less chance there is for errors to be introduced in a final drastic editing. Common failings, in younger authors especially, include: lack of topic sentence at start of paragraph; paragraph not confined to one subject; tendency to make paragraphs too short; clumsy sentences with too many dependent clauses, or, on the other hand, too much regard for the short-sentence fetish; beginning too many sentences with "however" or "thus"; use of clichés like "all the evidence goes to show"; use of two-dollar words where two-bit ones will do; use of too many abstract nouns; an over-addiction to "is present" and "exist" and a let-George-do-it attitude toward punctuation. Many common faults of this kind are noted in *Suggestions to Authors* and in standard books such as Fowler [1] or Quiller-Couch [2].

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[1] Fowler, H. W., A dictionary of modern English usage: Oxford University Press, London, 1940.

[2] Quiller-Couch, Arthur, On the art of writing, 5th ed.: Putnam, 1928.

The question often arises as to how much "editing" a Survey critic should do. Answers range from "a lot" to "practically none." The amount of editing will ordinarily depend on the inclinations and capabilities of the critics. It is a fact that well written papers are processed faster than poorly written ones; thus it will be to the advantage of both the Survey and the author if the critic edits a poorly written manuscript, even though it will receive later editing in the section of Texts. Avoid actually rewriting a paragraph except where absolutely necessary. Call attention to the faults and let the author struggle with them. He will do better if he is not spoon-fed too much. If the faults are minor, the critic should suggest changes that will lessen or remove the weaknesses.

Editing may be of several varieties, some of which may be the proper concern of the critic, as opposed to the editor. The quality of any scientific manuscript is a function of two commonly unrelated variables--the quality of the research, and the effectiveness of the presentation. The criticism of a manuscript is an equally two-sided problem--examining the soundness of the data, reasoning, and conclusions (reviewing); and helping the author to transmit his ideas into the mind of the reader with a minimum of distortion (one definition of editing). Everyone agrees that the critic's chief duty is to review, in the sense above defined. Only a qualified geologist is competent to judge what the author really means and to compare that with what he has said, or with the impression created in the mind of the reader. Such editing as the critic feels impelled to do should not necessarily require changing the author's inimitable style (assuming that Survey authors actually do have "styles"--in the sense that a literary artist has a style). The editing should make it possible for the average, even non-geologic, reader to understand what the author is trying to say. If the original style is unconventional, by all means leave it that way if it can be understood and falls within the accepted restrictions of English grammar. If "editing" is defined as "making more intelligible", this function is legitimate and should be one of the duties of the critic as well as the Editor. Editing that does not make the text more intelligible is nobody's duty.

Criticism of content is the main job and the greatest responsibility of the critic. If you think the author has drawn conclusions from insufficient evidence, suggest a less dogmatic presentation. If you think he has overlooked alternative hypotheses, state them briefly and let the author consider them. There is no "Survey policy" on expression of opinion. Assuming that the critic is familiar with the area or subject described, he may believe (1) that the author has his facts wrong, or (2) that the author has drawn unwarranted inferences from stated facts. The best solution to a question of fact, assuming that the disagreement is of sufficient importance, is a field (or office) conference, preferably with a referee. In matters of unwarranted inference, the critic's duty ordinarily

is to show the author where his reasoning is at fault, briefly indicate what he (the critic) thinks is a more logical course of reasoning, and leave it to the author to make any necessary modification.

Controversial hypotheses may better be presented first in an outside professional journal. Obvious advantages to the author are a wider circulation in the profession and generally prompter publication. Recommendation of a medium of publication is largely up to the author, but the critic might suggest an alternative.

Consider distribution of emphasis: "Tungsten deposits of Podunk" should be treated differently from "Geology and ore deposits of the Podunk quadrangle." In the former, petrology and sequence of post-ore lavas should be minimized; in the latter the author can go the limit if he has something to contribute.

Every areal paper has some phase of stratigraphy, structure, physiography, or other field of geology which, if not an outstanding contribution, at least is worthy of emphasis. Suggest how this phase can be given greater prominence, if it has not been emphasized. The author should be encouraged to emphasize what interests him most.

Over-detailed treatment of descriptive petrography is a common failing. What is generally wanted is petrology rather than petrography. Detail is permissible if something unusual is described or if it leads to some conclusion, but too often an over-conscientious description of all the thin sections is attempted, leading nowhere. Explain why condensation is desirable. Too often much space is devoted to the description of a perfectly insignificant, ordinary igneous rock down to the last minute accessory mineral. If it leads to any significant conclusions, economic or not, it is of course justifiable, but too often over-detailed description seems to be an inheritance from classroom discipline. Life is too short to describe everything in all possible detail. The author should concentrate on what is essential to the purpose of the paper.

A major failing in many manuscripts is the use of the detective-story method of creeping up on a conclusion. The author assembles pages of facts, in part seemingly unrelated, and at the end skillfully weaves them together into a triumphant climax. But by that time, unfortunately, the reader has forgotten many of the facts. When an author uses this method, suggest to him that the conclusion might best be clearly stated first, perhaps as a summary, followed by the facts that support it, which the reader can then follow intelligently in arriving at the conclusion. The critic should see that facts are not too much mixed with theory.

Illustrations should be checked carefully. Critics should be reminded of the requirements of proper copy, as given in *Preparation of Illustrations*, the *New list of map symbols*, and in the attached *Suggestions for submitting map copy to the editors and draftsmen.* The author's attention should be called to such errors as failing to insert captions for illustrations in the proper places in the text. Maps and sections will be rechecked by the map editor, but they are so important that they should be gone over carefully by the critic. See that they agree with each other and with the text, that boundaries and faults in the sections agree precisely with their position and their dips as indicated on the map. Above all be sure that the illustrations are intelligible and sufficiently well drafted to be copied correctly by the draftsman. Only inked or typed material is now regarded as acceptable. Make certain that names of places referred to in the text appear on the maps (unless this is obviously impracticable).

Even at this late date the following quotation from Survey Order No. 76, dated Dec. 1, 1916, by George Otis Smith, Director, is very pertinent to the review of illustrations.

> A geologist who can not draw boundaries and structure sections with sufficient accuracy to serve as copy needs further education in his profession. A draftsman's line although probably prettier is at best only as accurate as the data from which it is drafted and these data must be supplied by the geologist. Much of the necessary geologic compilation is highly educational to the young geologists and they are missing a large and valuable part of their training if they are not given a good healthy dose of it.

Many authors use too many photographs. The authors have been at the locality and know what the photographs mean, but the reader may not. Photographs too commonly appear to be portraits of the geologic hammer. Photographs of hand specimens or of landscapes may show very little not covered by a good text description. On the other hand, a really good illustration may save many pages of descriptive text. Check the photographs for aid in understanding the text and for quality of reproduction. Such checking calls for keen and objective discrimination. If the reviewer is in Washington, he should ask the section of Illustrations and the Photographic Laboratory for advice on the reproduction of the photograph, if necessary.

The average time required for the review of a manuscript intended for publication as a bulletin will be about 1 to 3 weeks. If the author and critic are in the same place, informal conferences during the progress of the review will shorten the time required. It is important that the critic should give full time to the job; pecking at it at odd times gets you nowhere.

United States

Department of the Interior

Geological Survey

Washington 25, D. C.

MEMORANDUM

To : Geologists in Mineral Deposits Branch

From : Olaf N. Rove

Subject: Suggestions for submitting map copy to the editors and draftsmen.

A large part of the delay in processing reports is caused by the submission of poor map copy. The observance of the rules for compiling good copy will materially hasten the time involved in putting your report through the mill.

1. Copy submitted should be in ink and, except for the degree of refinement of professional drafting, should be clear, complete, and in the same form as the final published map.

2. Conventional symbols as given in the "New List of Geologic Map Symbols" should be used. Other symbols should not be introduced unless the situation is not covered in the foregoing list.

3. Every sheet should carry its own Explanation. The author should check each sheet to be sure that every symbol used in the main body of the map also appears in the Explanation.

4. Copy for geological maps on bases other than the standard quadrangle sheets should be submitted on scales larger than the scales of final reproduction. A 1/3 to 1/2 reduction will be made from the original.

5. Maps in which formations are delineated by color or pattern should be submitted in two sheets. One copy should be complete with the contacts and colors or patterns (the color guide); the other copy should show only the contacts and structure symbols. The color guide may be a photostat or print of the contact and structure symbol map. If the map base is a standard topographic sheet the structure and contacts should be plotted on a photographic blue copy of the topographic sheet – the color guide may be traced from this. Photographic blue copies of the standard topographic quadrangle sheets on Draftex, enlarged 1.5 times, may be ordered from Washington.

Olaf N. Rove

Olaf N. Rove, Chief
Mineral Deposits Branch

Rarely it may happen that it is not practicable to return a reviewed manuscript to the author, and therefore the critic has the job of putting it in better shape before it is sent forward for the Director's approval. In these circumstances you should be particularly careful not to change the author's "style", even if you could do much better, or his conclusions, even though you disagree. It is his paper, not yours. Cut out obvious redundancy, improve arrangement where absolutely necessary, and hope for the best. Every effort should be made to return the reviewed manuscript to the author for revision.

The foregoing applies primarily to the review of manuscripts for publication as a bulletin or professional paper.

PAPERS FOR OUTSIDE PUBLICATION

Papers for outside publication are not at present edited in the section of Texts, where Survey publications are edited, so more detailed comments on expression and phrasing are desirable on the part of a critic in our branch. Most outside publishers appear to do little editing or at least do it badly. If expression is very poor and the paper needs a complete rewrite don't waste too much time on it. In general, critics should avoid rewriting the author's paper. Rewriting takes too much of the critic's time, is not good for the author's morale, and if indulged in too much, particularly with a young author, may develop a "let-George-do-it" attitude. Send the paper back with some of the worst passages indicated and be specific in telling what is wrong with them. You may be able to indicate where in *Suggestions to Authors* he might learn how to correct certain faults. Bear in mind that *Suggestions to Authors* is not infallible; it contains much good advice but not the whole duty of man.

Papers, for publication outside of the Geological Survey, that deal with one principal subject should be completely focussed on that subject. The critic should recommend condensation and elimination of non-pertinent material, even though it might be appropriate in a more general paper or in a Survey bulletin. Outside papers are read chiefly by specialists, and focus is essential. Inclusion of too much irrelevant matter is apt to irritate such readers, and also to diminish the chance of a paper being accepted.

It may be desirable to make a report on a mining district available through "open file", prior to regular publication. This type of release requires several copies; expense and time can be saved if a lengthy paper is cut down to essentials before being retyped and processed. Here the critic should work directly on the text, preferably a carbon copy, with a blue pencil. Most of the introductory material can be deleted, the general geology can be reduced to a skeleton and the history limited to production

tables; most of "ore deposits", however, and practically all the mine descriptions should be retained, and, of course, all geologic and mine maps. It should be clearly indicated on the copy that deletions apply to "open file" copy, not to the text for formal publication.

USE OF SARCASM

Sarcasm is an edged tool, to be handled with care. Used cautiously, a little may be all right and may add effectiveness to your criticism. If you know your man, and know he can take it, go as far as you like. If you overdo it on a thin-skinned victim you are likely to arouse a feeling of resentment that will not help in improving the manuscript. One good sport told a critic that sarcasm stings at first but that the sting wears off and the impression sticks.

THE PRINCIPLES OF POOR WRITING

By Dr. Paul W. Merrill[3]
Astronomer, Mount Wilson Observatory

Books and articles on good writing are numerous, but where can you find sound, practical advice on how to write poorly? Poor writing is so common that every educated person ought to know something about it. Many scientists actually do write poorly, but they probably perform by ear without perceiving clearly how their results are achieved. An article on the principles of poor writing might help. The author considers himself well qualified to prepare such an article; he can write poorly without half trying.

The average student finds it surprisingly easy to acquire the usual tricks of poor writing. To do a consistently poor job, however, one must grasp a few essential principles:

1. Ignore the reader.
2. Be verbose, vague, and pompous
3. Do not revise.

IGNORE THE READER

The world is divided into two great camps: yourself and others. A little obscurity or indirection in writing will keep the others at a safe distance; if they get close, they may see too much.

Write as if for a diary. Keep your mind on a direct course between yourself and the subject; don't think of the reader – he makes a bad triangle. This is fundamental. Constant and alert consideration of the probable reaction of the reader is a serious menace to poor writing; moreover, it requires mental effort. A logical argument is that if you write poorly enough, your readers will be too few to merit any attention whatever.

[3]Sci. Monthly, vol. 64, pp. 72-74, 1947.
Surveying and Mapping, vol. 8, pp. 244-246, 1948.

Ignore the reader wherever possible. If the proposed title, for example, means something to you, stop right there; think no further. If the title baffles or misleads the reader, you have won the first round. Similarly, all the way through you must write for yourself, not for the reader. Practice a dead-pan technique, keeping your facts and ideas all on the same level of emphasis with no telltale hints of relative importance or logical sequence. Use long sentences containing many ideas loosely strung together. *And* is the connective most frequently employed in poor writing because it does not indicate cause and effect, nor does it distinguish major ideas from subordinate ones. *Because* seldom appears in poor writing, nor does the semicolon – both are replaced by *and*.

Camouflage transitions in thought. Avoid such connectives as *moreover, nevertheless, on the other hand.* If unable to resist the temptation to give some signal for a change in thought, use *however.* A poor sentence may well begin with *however* because to the reader, with no idea what comes next, *however* is too vague to be useful. A good sentence begins with the subject or with a phrase that needs emphasis.

The "hidden antecedent" is a common trick of poor writing. Use a pronoun to refer to a noun a long way back, or to one decidedly subordinate in thought or syntax; or the pronoun may refer to something not directly expressed. If you wish to play a little game with the reader, offer him the wrong antecedent as bait; you may be astonished how easy it is to catch the poor fish.

In ignoring the reader avoid parallel constructions which give the thought away too easily. I need not elaborate, for you probably employ inversion frequently. It must have been a naive soul who said, "When the thought is parallel, let the phrases be parallel."

In every technical paper omit a few items that most readers need to know. You had to discover these things the hard way; why make it easy for the reader? Avoid defining symbols; never specify the units in which data are presented. Of course it will be beneath your dignity to give numerical values of constants in formulae. With these omissions, some papers may be too short; lengthen them by explaining things that do not need explaining. In describing tables, give special attention to self-explanatory headings; let the reader hunt for the meaning of P^1r_0.

BE VERBOSE, VAGUE, AND POMPOUS

The cardinal sin of poor writing is to be concise and simple. Avoid being specific; it ties you down. Use plenty of deadwood: include many superfluous words and phrases. Wishful thinking suggests to a writer that verbosity somehow serves as a cloak or even as a mystic halo by which an idea may be glorified. A cloud of words may conceal defects

in observation or analysis, either by opacity or by diverting the reader's attention. Introduce abstract nouns at the drop of a hat--even in those *cases* where the *magnitude* of the *motion* in a downward *direction* is inconsiderable. Make frequent use of the words *case, character, condition, former* and *latter, nature, such, very.*

Poor writing, like good football, is strong on razzle-dazzle, weak on information. Adjectives are frequently used to bewilder the reader. It isn't much trouble to make them gaudy or hyperbolic; at least they can be flowery and inexact.

DEADWOOD

Bible: Render to Caesar the things that are Caesar's.

Poor: In the case of Caesar it might well be considered appropriate from a moral or ethical point of view to render to that potentate all of those goods and materials of whatever character or quality which can be shown to have had their original source in any portion of the domain of the latter.

Shakespeare: I am no orator as Brutus is.

Poor: The speaker is not what might be termed an adept in the profession of public speaking, as might be properly stated of Mr. Brutus. (Example from P. W. Swain. Amer. J. Physics, 13, 318, 1945.)

Concise: The dates of several observations are in doubt.

Poor: It should be mentioned that in the case of several observations there is room for considerable doubt concerning the correctness of the dates on which they were made.

Reasonable: Exceptionally rapid changes occur in the spectrum.

Poor: There occur in the spectrum changes which are quite exceptional in respect to the rapidity of their advent.

Reasonable: Formidable difficulties, both mathematical and observational, stand in the way.

Poor: There are formidable difficulties of both a mathematical and an observational nature that stand in the way.

CASE

Reasonable: Two sunspots changed rapidly.

Poor: There are two cases where sunspots changed with considerable rapidity.

Reasonable: Three stars are red.

Poor: In three cases the stars are red in color.

RAZZLE-DAZZLE

Immaculate precision of observation and extremely delicate calculations . . .

It would prove at once a world imponderable, etherealized. Our actions would grow grandific.

Well for us that the pulsing energy of the great life-giving dynamo in the sky never ceases. Well, too, that we are at a safe distance from the flame-licked whirlpools into which our earth might drop like a pellet of waste fluff shaken into the live coals of a grate fire.

DO NOT REVISE

Write hurriedly, preferably when tired. Have no plan; write down items as they occur to you. The article will thus be spontaneous and poor. Hand in your manuscript the moment it is finished. Rereading a few days later might lead to revision – which seldom, if ever, makes the writing worse. If you submit your manuscript to colleagues (a bad practice), pay no attention to their criticisms or comments. Later resist firmly any editorial suggestion. Be strong and infallible; don't let anyone break down your personality. The critic may be trying to help you or he may have an ulterior motive, but the chance of his causing improvement in your writing is so great that you must be on guard.

FINAL SUGGESTIONS FOR POOR WRITING

Do not read:

Albutt, Clifford. Notes on the Composition of Scientific Papers. Macmillan, 1923.

Flesch, Rudolf. The Art of Plain Talk. Harper, 1946.

Graves and Hodge. The Reader Over Your Shoulder. Macmillan, 1943.

Quiller-Couch, Arthur. On the Art of Writing. (V). Putnam, 1928.

Suggestions to Authors of Papers Submitted for Publication by the United States Geological Survey. U. S. Government Printing Office, 1935.

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